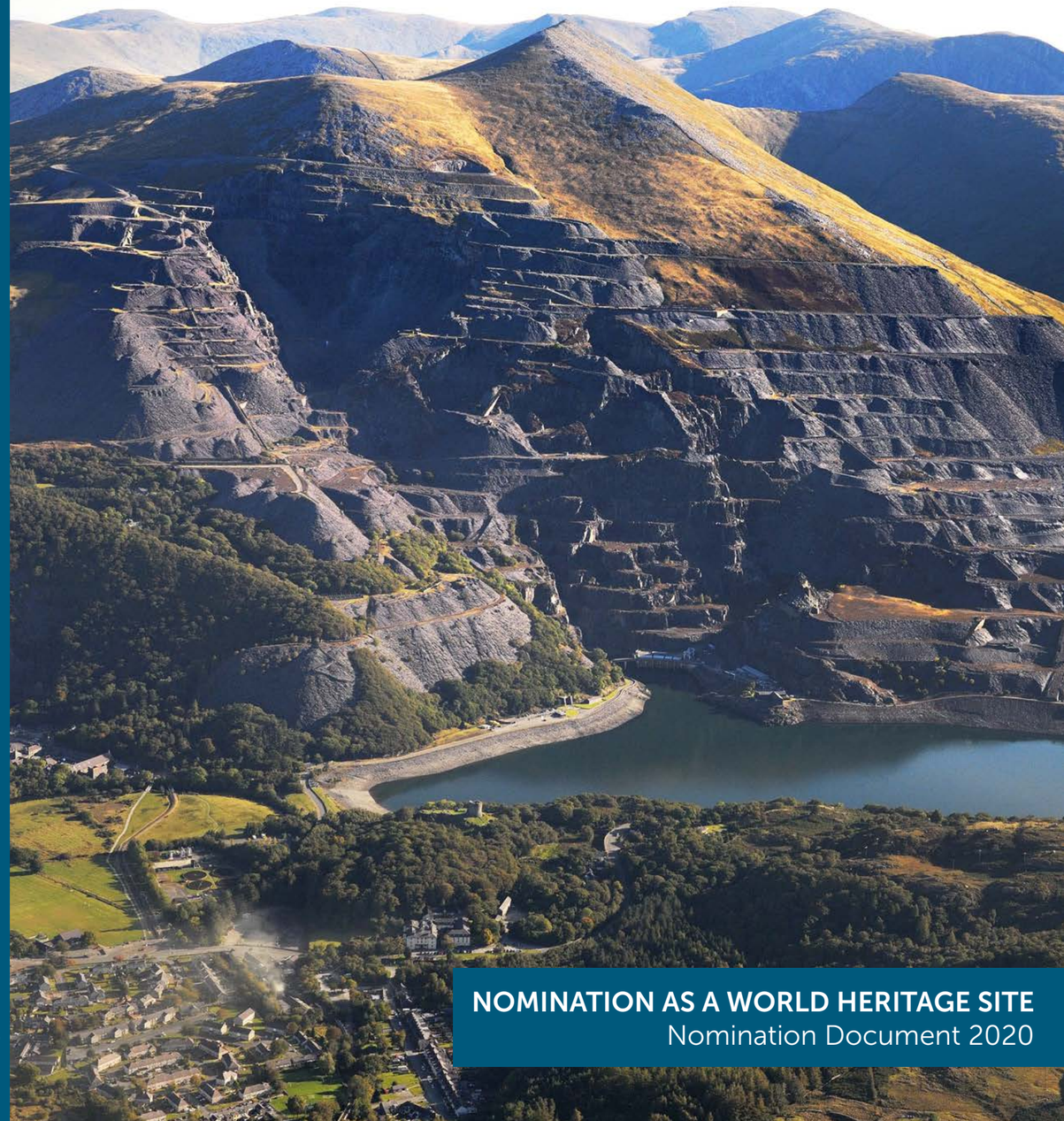
The Slate Landscape of Northwest Wales was formed by the quarrying, processing and transportation of slate to produce roofing materials and architectural materials for global markets, from the late eighteenth century to the twentieth. As well as the quarries and mines themselves, this landscape has also been shaped by the need to tip huge amounts of waste rock; to process and transport slate; to manage water to power machinery; to house quarrymen and their families, and to provide for their material, moral and intellectual well-being.

Tirwedd Llechi Gogledd Orllewin Cymru
The Slate Landscape of Northwest Wales

Llechi Cymru
Wales Slate

Tirwedd Llechi Gogledd Orllewin Cymru

The Slate Landscape of Northwest Wales



NOMINATION AS A WORLD HERITAGE SITE
Nomination Document 2020

2.a Description of Property

Introduction to the Nominated Property

The Slate Landscape of Northwest Wales is a serial property located in Gwynedd, Wales, comprising six Component Parts with a total area of 3259.01 hectares. This is a coherent cultural landscape that represents the broader heritage of the Welsh slate industry but, more specifically, its pre-eminent centre in the mountains and valleys of the Snowdon massif. It was from here that the most profound global impact of Welsh slate came – as a world leader in the production of finely-grained roofing material in the heyday from around 1780 to 1940, of ingenious technical innovation in quarrying and stone processing, and moreover as a prototype for narrow gauge railway technology for mountainous environments. It is here, too, that sustained exploitation of slate transformed a sparsely populated marginal agricultural upland landscape into one dominated by industry, on a scale so exceptional, indeed so monumental, as to compete with the natural grandeur of Snowdonia.

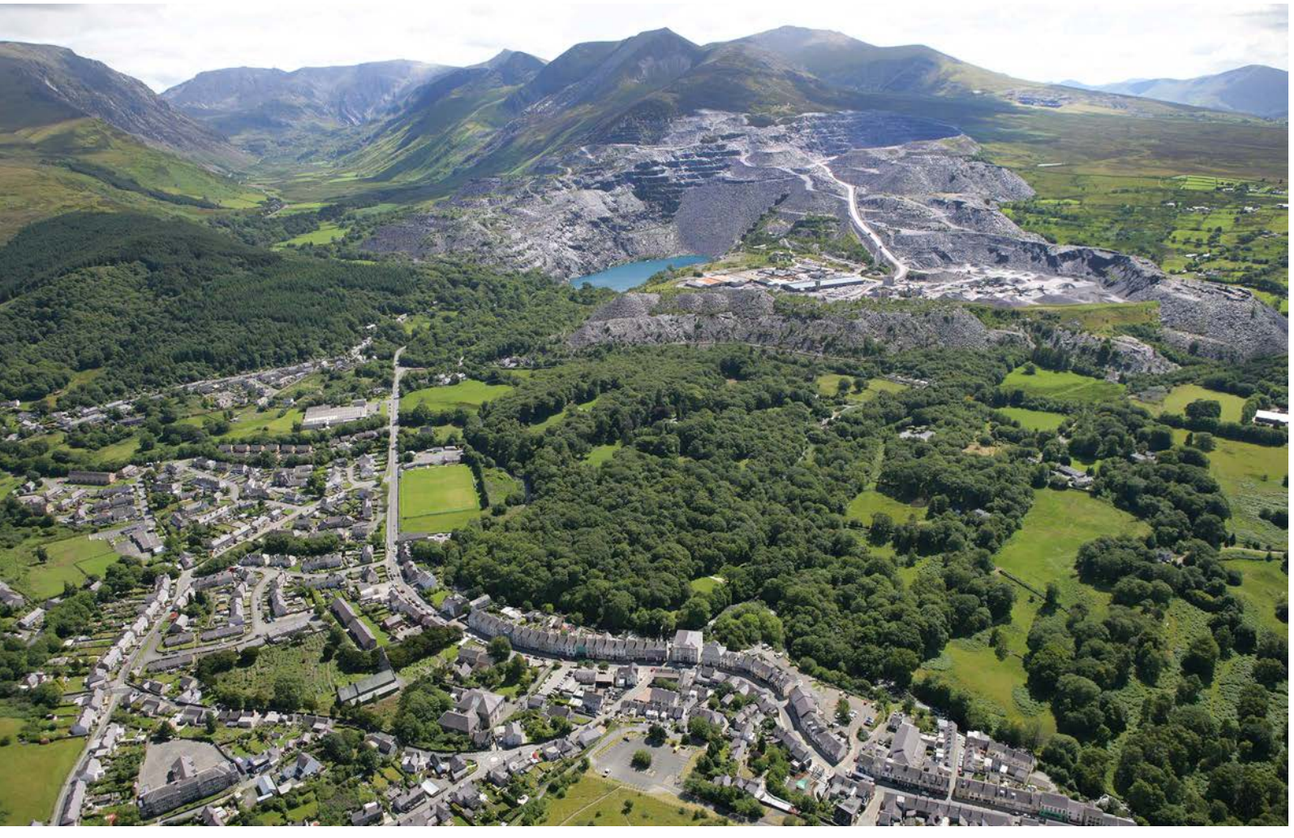


Figure 2.2. Bethesda, in the foreground, is overlooked by Penrhyn Slate Quarry (Component Part 1). Once the largest slate quarry in the world, Penhryn is still active in the wider protected area (top right, outside the Nominated Property) – a wholly compatible activity supporting a vivid understanding of the industry and still producing slate for prestigious conservation contracts in some of the world's most historic buildings.

Physical testimony is characterised by exceptional survival; the vast majority of this evolved landscape remains intact and highly legible. The extraction of Gwynedd's mineral wealth shaped not only the landscape, but also the communities who lived and worked in these mountains. A rich and enduring social legacy is partly sustained by continued slate exploitation outside of the Nominated Property in the wider protected area, supporting a living tradition, its knowledge and know-how. This 'most Welsh of Welsh industries' remains an important employer, and continues to support modern-minded and outward-looking communities who take pride in their heritage, their distinctive culture and their everyday day use of a Celtic language, recognised by UNESCO as an Indigenous Language.

The nomination comprises six Component Parts, which together capture the full geographical distribution of slate exploitation, its scale, diverse technical nature and the wider landscape impact, which includes settlement and transport.

Spatial relationship is governed by the location of several principal outcrop belts that belong to the largest regional deposit of high-grade slate in the world. Production centres range from the tops and sides of mountains to lower slopes and valley floors, depending on the orientation of the slate beds or 'veins' that are part of a complex folded geological structure. Each one makes a distinctive and substantial contribution to the proposed Outstanding Universal Value in the type of geological deposit and the way that the slate was won, handled and processed; where there are similarities, these provide important evidence for the transfer of skills and technology by internal migration.

Similarly, a range of settlement types is necessary to support overall functional integrity and to exemplify the variety of social forces at work as this region underwent industrialisation, the different contemporary assumptions about how an expanding workforce could be housed, and the ways in which its social, religious and cultural welfare could be ensured.

Figure 2.3. Bethesda High Street (Component Part 1).

Settlements, including Bethesda, Deiniolen and the town of Blaenau Ffestiniog, developed in close proximity to the quarries and mines, their location further dictated by topography. In some cases, their development was heavily influenced by the patronage of aristocratic landowners and wealthy investors, elsewhere by resistance to them.

This is a railway landscape, too, brought into being by, and an essential element of, the industrial exploitation of the slate resources of Snowdonia as vast tonnages were conveyed downhill in long trains of small wagons. Not only is the technical relationship of these railways to the topography through which they pass exceptional, but they also follow a strong and evident evolutionary pattern within the Nominated Property. Their design becomes increasingly sophisticated, beginning with methods adapted from canal engineering through horse-and-gravity operation to purpose-built locomotive-worked public railways. The concept of the mineral-carrying iron railway to an approximate gauge of 0.6 metres was evolved in the Nominated Property from 1801 onwards; in the 1860s the Ffestiniog Railway took this technology into the age of steam traction and passenger transport, providing a prototype that was emulated world-wide.

Slate production is captured by this network of physical linear linkages, from the quarry working faces to the processing mills where blocks were sawn, to the new, purpose-built slate harbours at Port Penrhyn and Porthmadog and to main-line railways.

Figure 2.4. The Ffestiniog Railway (Component Part 5) was built to transport slate and provided the precedent for the World Heritage Darjeeling Himalayan Railway, India. It remains operational as an internationally recognised visitor attraction.

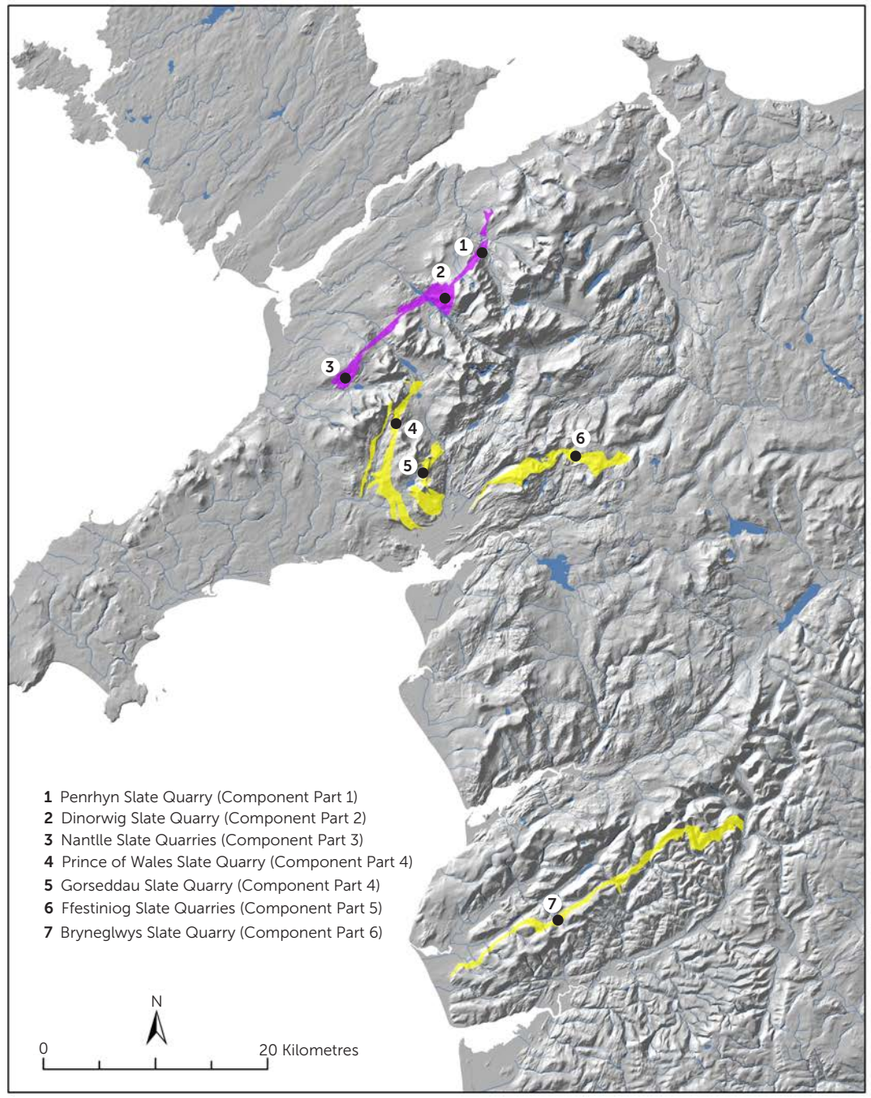
Figure 2.5. Port Penrhyn, with Penrhyn Castle and Park beyond (Component Part 1). Constructed between 1790 and 1855, the slate port marks the terminus of an intact linear cultural landscape – from quarry to wharf, connected by dedicated transport links – all originally under one ownership.

Links between Component Parts

Together, the six Component Parts represent a powerful and impressive relict landscape of slate exploitation with great unity and unparalleled compositional and functional integrity.

Geological linkages

Each Component Part contains a strict selection of the most significant and best examples of surface quarries and underground mines located within three principal Cambrian and Ordovician slate deposits that stretch for 60km in a northeasterly to southwesterly direction. The mountainous landscape, with its steep and rugged topography, heavy rainfall and frequent winter snow, includes what were, by the nineteenth century, the largest and most productive slate quarries and their underground counterparts (mines) in the world: Penrhyn, Dinorwig and Ffestiniog, each with their respective landform-scale waste tips.



Map 2.1. Northwest Wales, showing geological linkages between Component Parts, topography, rivers and lakes. The Cambrian Purple Slate Vein is shown in purple and the Ordovician Slate Vein in yellow.

Figure 2.6. Dinorwig Slate Quarry (Component Part 2), where the stepped galleries soar for over 500m above the waters of Peris Lake. In the eighteenth and early nineteenth centuries, Dinorwig slate was transported by small boats along the lower lake to carts at the further end.

Slate technology: innovation and transfer linkages

Each Component Part is associated with innovative technology and the ingenious use of water power for pumping and for extracting, hoisting and processing slate. The technology of extraction varied from mountain to valley; so too the way that the workings were dewatered and the slate was hauled out. Innovation can also be seen in the processing mills, often located on bleak mountainsides where men would often stay in purpose-built barracks to alleviate daily toil. Technology transfer is evidenced in the Nominated Property by inward means (e.g. Cornish pumping), between Component Parts (e.g. stepped galleries from Penrhyn Slate Quarry) and by outward means (e.g. Ffestiniog Railway to many parts of the world). All Component Parts include rare testimony in a range of surviving equipment and artefacts from specific periods and phases, both above and below ground.

Figure 2.7. The Dorothea Cornish beam engine (Component Part 3) is complete and in its original house. Built in 1904-1906, it is the penultimate example ever constructed and the only twentieth century survivor, marking the end of Cornwall's long pre-eminence in manufacturing these giants of steam.

Functional/process linkages

Inclined planes, level railways, shafts and aerial ropeways moved slate blocks hewn from cavernous underground workings or from deep pits and great mountainside galleries to the mills where they were sawn and split. From the mills, railways continued the negotiation of challenging mountainous terrain to transport the product to specially constructed slate ports in the shallow waters of broad estuaries and tidal straits. From here the product was exported to national and international markets. Component Parts each contribute different aspects to the Nominated Property as a whole.

Settlement patterns bear an intimate relationship with geology, topography and ownership, whilst specific social infrastructure reflects a unified and distinctive culture that once developed in relative isolation: scattered slate-workers' cottages and smallholdings, villages and the 'city of slates', Blaenau Ffestiniog – one of the United Kingdom's best-surviving Victorian industrial towns – and the great houses and estates that exemplify ownership, organisation and development under a British capitalist model of rural industrialisation.

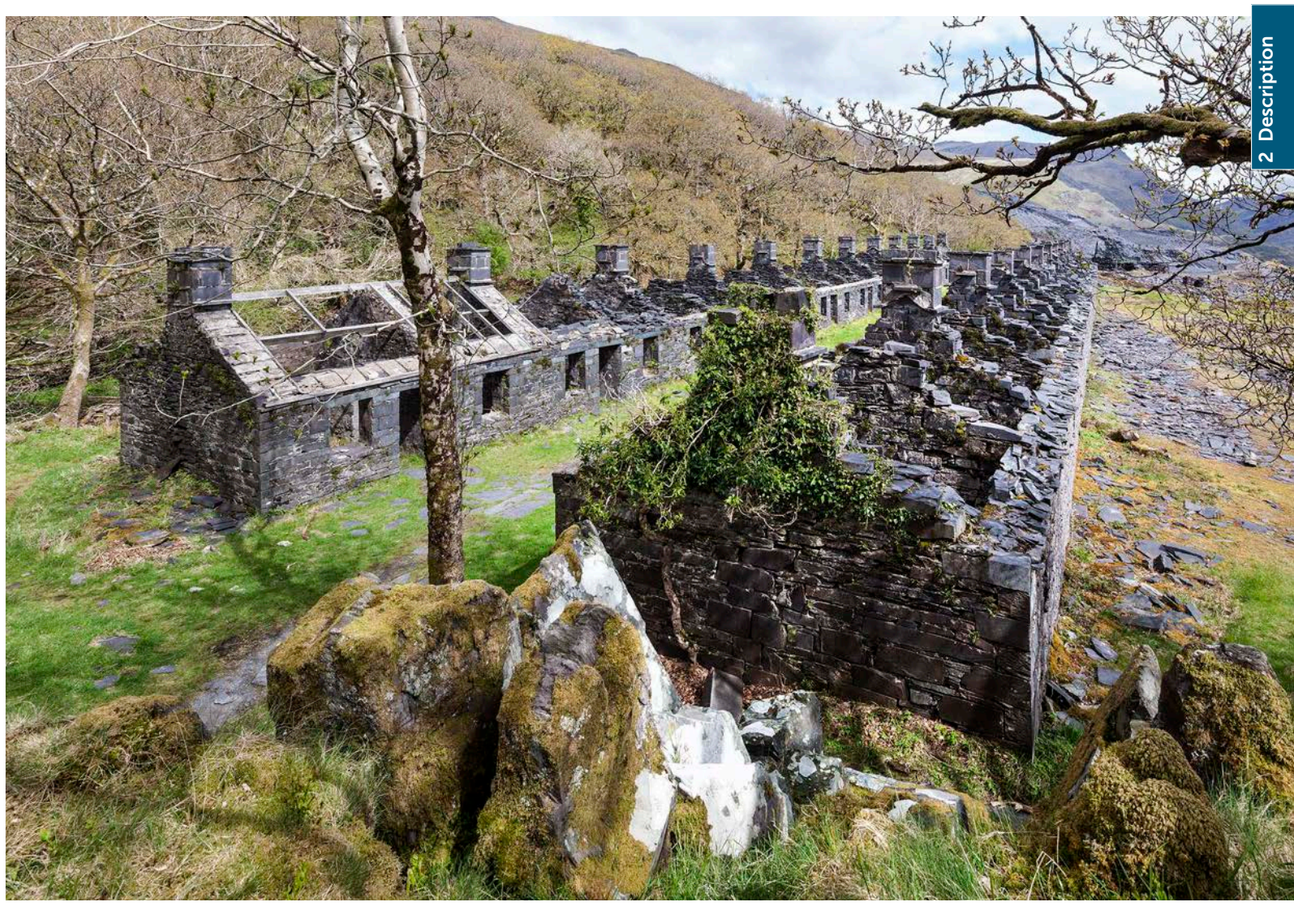


Figure 2.8. The Anglesey Barracks, or *y dre' newydd* ['the new town'] (Component Part 2) were built in the 1870s at Dinorwig Slate Quarry to attract and accommodate workers from the more distant parts of Northwest Wales. The form of the settlement comprises traditional single-storey, two-room, rural cottages that have been adapted to create a pair of industrial rows that face each other across the 'main street'.

Architectural linkages

Industrial architecture comprises a mix of characteristic, industry-specific, features that occur throughout the Nominated Property: from the ubiquitous masonry inclined planes and their drum houses and the massive slate bastions of chain incline ropeways, to the long and low slate slab mills or the rudimentary slate-processing shelters known as *gwaliau* ('lairs'). Some features are singular, such as the majestic, abbey-like, water-powered Ynysypandy slate-slab mill that served the commercially unsuccessful Gorseddau Slate Quarry.

Much of the vernacular architecture is not only common throughout the Nominated Property but is also typical of much of Wales, and indeed elsewhere, particularly in nineteenth century regions of industrial Britain. However, it is an essential component of the exceptional cultural landscape, without which the winning of high-quality slate in such a remote part of Britain could not otherwise be fully understood.

Shared social linkages

The Nominated Property, as a whole, embraces a shared, distinctive and unique testimony of intangible values that represent the cultural tradition of Welsh slate. Whilst *The Slate Landscape of Northwest Wales* is predominantly a relict landscape, its railways have been the subject of early conservation movements that continue to provide world-famous journeys by steam, and its towns and villages remain vibrant living places. This living tradition also includes (outside the Nominated Property in a small part of the wider protected area) the continued extraction and processing of high-quality slate for prestige, and conservation, projects across the world. Present-day quarrying not only sustains traditional skills and provides slate for worldwide conservation, but also demonstrates continuity and change in an industry that remains vital to the region and its communities. In this way well-managed active quarrying within the wider protected area is functionally important as a support to the property and the protection of its values.

Figure 2.10. Underground workings at Bryneglwys Slate Quarry (Component Part 6). Selected examples of the superlative, and most technically diverse, underground workings are included in Component Parts 5 and 6. Historic artefacts survive well in these environments.

Figure 2.9. Ynysypandy Slate-slab Mill (Component Part 4)

Setting

The setting of the Nominated Property ranges from an extensive rural upland area, dominated by spectacular yet often bleak mountain ranges that include the highest peaks in Wales and England, to a more gentle, open yet narrow plateau (up to 7 kilometres wide from north to south) that ends in the coastline of the Irish Sea in the north and west. Dramatic vistas reveal close and contrasting visual relationships, and emphasise the strong connectivity between the elements in each Component Part, as well as with the wider landscape of mountain and sea-coast.

The Nominated Property, including its key views, lie within a wider protected area through designation as a National Park and registration as Landscapes of Outstanding Historic Interest that will serve the purpose of a Buffer Zone.

Language and intangible heritage; spirit and feeling

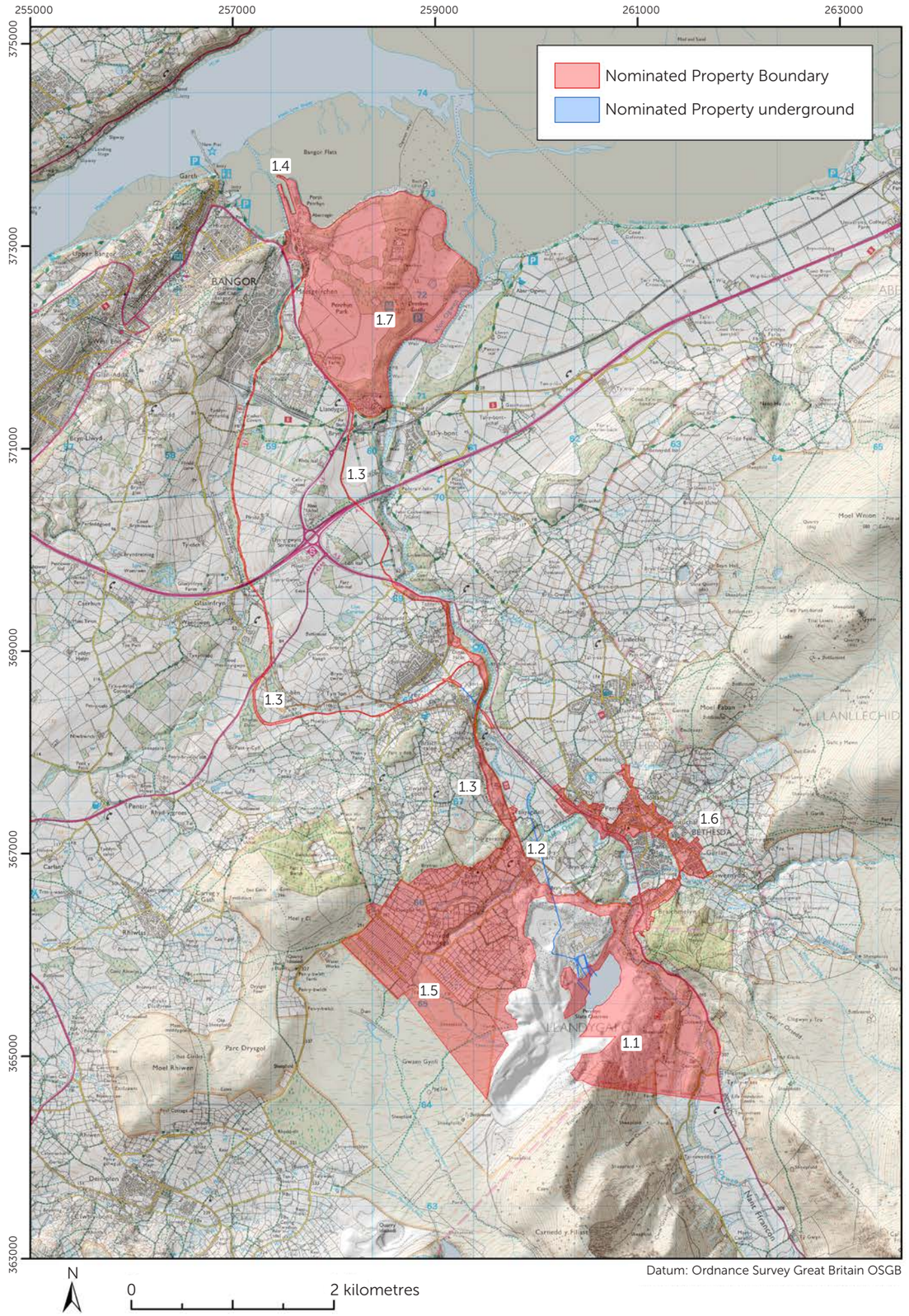
This is manifestly a cultural landscape where people had to earn a living in a harsh environment where, as a consequence, a minority language has remained strong. Place-names within the Nominated Property are almost entirely in Welsh – the only exceptions are the fanciful names which the quarrymen conferred on locations where they worked, such as 'Sebastopol' or 'Burma Road', reflecting their interest in current events, and the Biblical names they conferred on their places of worship, such as 'Carmel' and 'Bethesda'. The growing pains of industrialisation, and the conflict between those who profited from slate and those who worked it, are evident in the different types of housing and places of worship, and in the varied types of settlement within the Nominated Property.

Figure 2.11. The archaeologically rich, relict quarry landscape of the Nantlle Valley (Component Part 3), looking northwest over the Irish Sea. The deep flooded quarry pits illustrate the vertical nature of the slate veins in a valley setting, offering a landscape and technical contrast to the mountainous terrain of other Component Parts.

COMPONENT PART 1

Penrhyn Slate Quarry and Bethesda, and the Ogwen Valley to Port Penrhyn

Figure 2.12. The whole of Component Part 1 is visible in this aerial view of the Ogwen valley, from the quarry in the distance to the port in the foreground, and the course of the railways that connected them. Also evident are the quarry settlements and the Neo-Norman castle of the owning family.



Map 2.2. The boundaries and Elements of Component Part 1: Penrhyn Slate Quarry and Bethesda, and the Ogwen Valley to Port Penrhyn (Scale 1:50,000).

Location and setting

This is the most northerly of all the Component Parts, a 9km linear south-south-west to north-north-east trending industrial landscape in which all seven elements are intimately related in their direct development by aristocratic owners.

The course of the Component Part captures the entire process flow, beginning in the south at the great Penrhyn Slate Quarry, once the largest slate quarry in the world. This is located where the slate vein crosses the Component Part at the point where a steep-sided glacial formation to the south opens out onto the lower Arfon slopes. Geologically, this is part of the Arfon Slate District (Cambrian age) that also includes Component Parts 2 and 3. Penrhyn Slate Quarry is separated from Area 2 *Dinorwig Slate Quarry Mountain Landscape*, roughly 5km to the southwest, by the Elidir Fawr mountain (924m above sea level, the northernmost peak of the Glyderau range).

The village of Bethesda, which developed to serve the Quarry, is located 1km north, across the Ogwen valley which runs between the low ridge of the Glyderau mountains in the west and the Carneddau mountains in the east before flowing north-northwest for around 8km to within 200m of Penrhyn Castle before discharging into the sea. The earlier of two successive slate railways from the quarry mills creates a linear landscape feature that follows the contour of the Ogwen Valley as it cuts through a relatively open agricultural plateau until it reaches the elevated estate landscape of Penrhyn Castle and Park. Here the river flows to the east of the Castle whilst the railroad skirted the Park to the west before reaching Port Penrhyn that was developed as a slate port in the northwest of the Park, on the eastern fringe of the city of Bangor. The later railway, again a prominent linear landscape feature, crosscuts westwards away from the Ogwen Valley around a third of its way to the Port and picks up the Cegin valley instead. The Port extends its reach into the estuary-like character of the muddy Bangor Flats, midway between mean high and low water on the shores of the eastern end of the Menai Strait, which separates mainland Wales from the island of Anglesey.

Penrhyn Castle was the seat of the aristocratic dynasty that owned and developed most of this Component Part, and that placed the slate industry of Northwest Wales on a capitalised industrial footing from the late eighteenth century onwards. It dominates its surroundings, and is one of the most important large country houses in Wales (its 70 roofs cover 0.4 ha). Views from here extend northeast into where the Menai Straits open to Liverpool Bay, northwest across to Anglesey, and south to the mountains of Snowdonia and Penrhyn Slate Quarry – one of the sources, along with the owners' slave plantations in Jamaica, of the wealth that enabled this picturesque yet vast Neo-Norman fantasy castle to be built. Their ornamental dwellings, dairies, farms and imposing churches contrast with the sombre terraced houses and Nonconformist chapels of the quarrymen's freehold settlement at Bethesda.

Summary

The Component Part includes the relict landform of the great galleried Penrhyn Slate Quarry, worked continuously since the late eighteenth century, a water-powered mill complex, associated transport systems to the private harbour at Port Penrhyn, and distinctive and contrasting workers' settlements at Bethesda and Mynydd Llandygai. Penrhyn Castle and Park was formerly the home of the major aristocratic quarry-owning family.

The Ogwen valley is distinctive in terms of the British Industrial Revolution as an integrated extraction landscape developed directly by its aristocratic owners, just as they also improved its agricultural economy. This reflects the strongly managerial approach they developed on their other major land-holdings, including the source of their founding wealth, sugar-growing slave-estates in Jamaica.

Elements

The seven Elements of this Component Part date from the 1780s to the early twentieth century within a landscape of estate improvement implemented by its aristocratic owner.

Table 2.1 Component Part 1 Elements

Element 1.1	Penrhyn Slate Quarry
Element 1.2	Felin Fawr Slate-Slab Mills
Element 1.3	The Penrhyn Slate Quarry Railroad and Penrhyn Slate Quarry Railway
Element 1.4	Port Penrhyn
Element 1.5	Mynydd Llandygai Settlement
Element 1.6	Bethesda Village
Element 1.7	Penrhyn Castle and Park

Figure 2.13. The scale of historic working at Penrhyn Quarry is remarkable, and retains the system of stepped galleries first introduced at the turn of the eighteenth and nineteenth centuries. These are evident both in the active workings in the wider protected area and in the relict landform of the quarry within the Nominated Property.

Element 1.1 consists of the relict landform of a quarry – once the largest of its type in the world – in which slate is still worked outside the Nominated Property in the wider protected area, most profitably for high-quality architectural products. The system of stepped galleries, first introduced here at the turn of the eighteenth and nineteenth centuries, is evident, with extensive areas of slate tipping to either side. Within the relict quarry, important features include a hospital (in ruins), and a rare technical combination of significant water-driven machinery, including two intact and preserved water-balance shafts still retaining their cages and mechanism, a hydraulic engine and its associated pumps, and a turbine. These complement the surviving waterwheels at the Felin Fawr slate-slab mills. The underground drainage levels and their railway systems remain intact and accessible.

Penrhyn Slate Quarry is the relict landform of what was by the early nineteenth century the largest slate quarry in the world, working over twenty stepped galleries. Waste rock was tipped to the north, south and east of the working faces. These tips were fed by railway lines from 1801 to 1965, leading to the formation of the distinctive 'finger-run' piles of rubble. Present tipping is carried out to the north of the Nominated Property, and carefully avoids the relict landform of the Quarry.

In the 1840s the system of inclined planes from the quarry pit was abandoned in favour of a system of water-balance shafts. Two of these shafts preserve their head-frames and other equipment, and connect with a network of tunnels.

Initially all the reduction of blocks and splitting was carried out by hand in shelters called *gwaliau* by the quarrymen. From the beginning of the twentieth century, these came to be superseded by electrically-powered mills housing saw tables in the main processing area, but examples survive within the Nominated Property.

Figure 2.14. Penrhyn Quarry made extensive use of water-balance systems from the mid-nineteenth century until 1965, when two surviving examples were retained for their heritage value. Sebastopol water-balance shaft was sunk during the Crimean war, and recalls the Allies' capture of the city in 1855. It connects with the accessible network of tunnels and drainage levels in the Quarry.

The introduction of the water-balance shafts from the 1840s and the deepening of the pit required the cutting of a drainage level 1.9 kilometres long to the Ogwen River by experienced miners from the coal and iron town of Merthyr Tydfil in South Wales. Underground machinery at Penrhyn Slate Quarry includes intact railway systems, and a hydraulic engine and pumps in a shaft now flooded to just below the floor level.

Figure 2.15. Hydraulic (or water-pressure) engines were never common in Britain, but Penrhyn Slate Quarry installed this triple-cylinder machine to pump the quarry pit in 1872, and preserved it *in situ* when it fell out of use in the 1930s.

Element 1.2 Felin Fawr Slate-Slab Mills

Element 1.2 consists of a conserved processing and engineering complex on the course of the Penrhyn railway systems of 1801 and the 1870s from the quarry to the sea, located where they first crossed a fall of water powerful enough to drive machinery. This was the site of the innovative slate-slab mill of 1802 – the earliest known location in the world to have used circular saws to cut stone. The two surviving waterwheels and most of the present buildings date from the mid-nineteenth century or later, and are in appropriate industrial re-use.

The industrial complex known as *y Felin Fawr* ['the big mill'] is situated to the north of Penrhyn Slate Quarry, at the first location where the railroad crossed a stream which could be dammed to turn water-wheels. This was where slate slabs were sawn and shaped, and where the quarry's engineering needs were met. It operated until 1965 and is now in re-use by local businesses.

A mill to saw raw blocks into architectural slabs had been established here by 1802, when it was equipped with circular saws. This is the earliest known location in the world to have used circular saws to cut stone; it narrowly predates their use to saw *lignum vitae* in the Royal Navy Dockyard at Portsmouth. Later mills were erected *c*. 1846 and in 1855, and the two present mills in 1865-6, to the design of William Francis (d.1887) and his son John Francis (1828-1879), the quarry managers. The mills were consolidated in 1999-2000 by Gwynedd Council for conversion to light industrial units.

The slate slab-built locomotive shed added against the southern gable wall of the western mill was built for the first locomotive on the Penrhyn Quarry Railway in December 1875, with a later siding for an internal combustion locomotive. The foundry dates from 1866, replacing an earlier structure erected in 1834. It is typical of its period, built out of sawn slate slabs with quoins of igneous rock. The blast was provided by a suspension water-wheel which survives in a building to the eastern perimeter of the site, by Henry Sugden and Son of Bramley, near Leeds.

The houses Tai'r Stablau ['stable-houses'] were built in 1875 on the site of facilities for the horses that formerly pulled the slate wagons to Port Penrhyn. Later structures include a two-bay locomotive repair shop, built out of sawn slate blocks. The more northerly range housed a range of machine tools; in the other, an inspection pit and an overhead gantry crane survive. At the southern perimeter of the site, where the railway passed into the quarry, is a fine slate-slab road over-bridge dating from 1900. The river which powered the complex follows its original course and is apparent both upstream and downstream. The culvert through which it passes under the site is accessible.

Figure 2.16. This aerial view of the Felin Fawr slab mill and engineering complex shows how the two slab-mills and their associated engineering complex were constructed above a culvert carrying the stream that powered the waterwheels. Also evident are a foundry, the course of the railway, locomotive sheds and workers' housing. The buildings are now operated by a local business, and have been conserved.

Figure 2.17. Two nineteenth century waterwheels survive at Felin Fawr; this one powered the foundry blower.

Element 1.3 The Penrhyn Slate Quarry Railroad and Penrhyn Slate Quarry Railway

The original 0.6 metre iron railroad of 1801 used both horse-traction along lightly-graded sections and counterbalanced inclined planes to connect the quarry with Port Penrhyn. It is the design ancestor of many narrow gauge railways built subsequently, and provides a contrast with its steam railway replacement built in the 1870s, operational until 1962. Their courses run parallel to each in places and include impressive retaining walls as well as an early railway viaduct and a remarkable intact inclined plane winding house.

Both these railway systems transported slate from Penrhyn Slate Quarry to Port Penrhyn. In places their formations run adjacent to each other; elsewhere they follow different routes. They illustrate not only the development of the distinctive technology of the narrow-gauge railway within the slate industry of North Wales but also how it evolved in a global context. This is evident in its links with both earlier and later technology; the original 0.6 metre iron railroad of 1801 used both horse-traction along lightly-graded sections and counterbalanced inclines, in the manner of a canal and its flights of locks. It used innovative cast-iron edge rails inspired by recent practice in Blaenavon (inscribed on the World Heritage List as an industrial landscape in 2000) and other South Wales ironworks. Charles Easton Spooner of the Ffestiniog Railway designed the 1870s steam-powered replacement for the horse railroad. It follows a sinuous and steep course – the maximum gradient is 1 in 33. By this time, small but powerful steam locomotives could haul significant loads up steep gradients, and the use of inclined planes, with their potential for delay, was no longer necessary. The Penrhyn Slate Quarry Railway operated until 1962.

Internal railways within Penrhyn Slate Quarry were built to the same gauge, and ran to over 80km of track. They were replaced by off-road vehicles in 1965, but the course of many of the inclined planes is evident, as is the formation of the branches used to tip waste rock. Track survives in the underground part of the quarry.

Figure 2.18. The course of the Penrhyn Slate Quarry Railway is evident in this view. This section operated from 1879 to 1962.

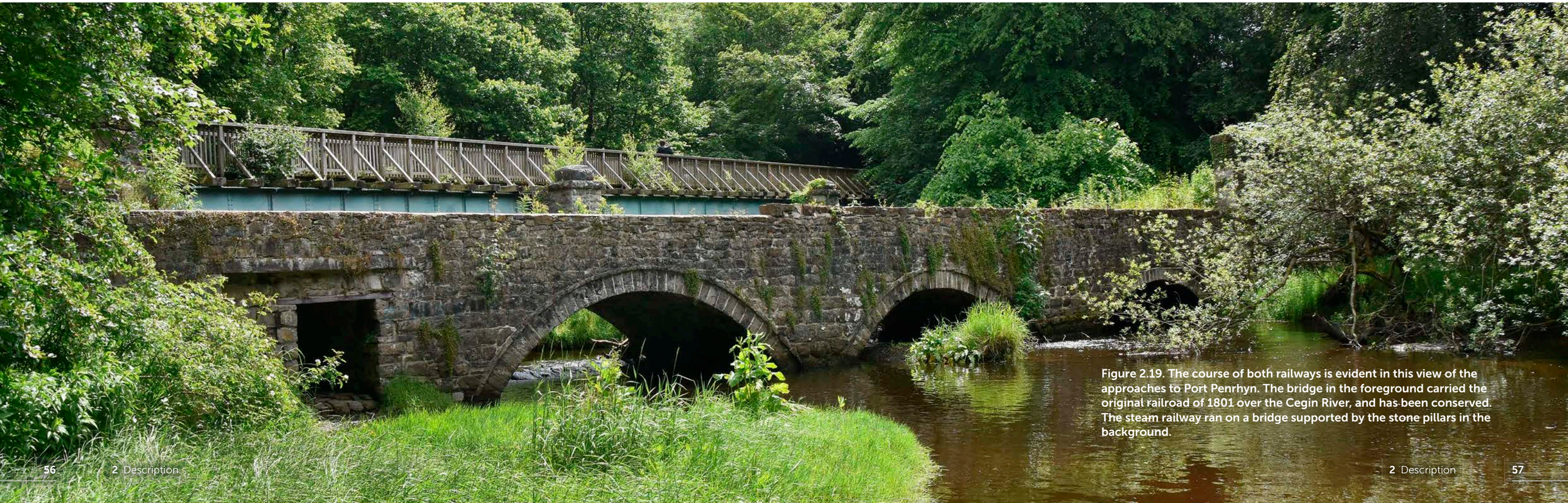


Figure 2.19. The course of both railways is evident in this view of the approaches to Port Penrhyn. The bridge in the foreground carried the original railroad of 1801 over the Cegin River, and has been conserved. The steam railway ran on a bridge supported by the stone pillars in the background.

Element 1.4 Port Penrhyn

Developed after 1790 as an engineered export harbour for Penrhyn slates, and extended in 1803, 1829-30 and 1855; in use as a commercial harbour, retaining its warehousing (1790s), and its Victorian office, circular privy, locomotive shed and carriage shed.

Port Penrhyn lies at the east end of the Menai Strait, which separates Anglesey from mainland Wales, adjacent to the town of Bangor and to Penrhyn Castle, and was the main shipping point for Penrhyn slate from the late eighteenth century to the mid-twentieth.

The River Cegin enters from the south. The earliest shipping point for slate was the pool upstream of the confluence, where a plan of 1768 shows a road approaching from the east with a possible quay alongside. In 1790 Benjamin Wyatt designed stone quays with a small stone pier and a warehouse at the mouth of the Cegin River; a further small quay was constructed by 1803, lengthened in 1828-1830. All of these survive. In 1855 further construction took place, resulting in the present harbour.

Port Penrhyn was initially served by the quarry road, then by the horse-drawn railroad of 1801, by a siding from the Chester & Holyhead Railway in 1852, which enabled slates to be distributed by the national rail network as well as by sea, then by the steam-worked narrow-gauge Penrhyn Slate Quarry Railway from the 1870s (Element 1.3).

Port Penrhyn remains in use as a commercial harbour and occasionally exports some crushed slate. Structures include: the warehouse, which contains eighteenth century fabric and is now offices and the head-quarters of Agoriad Cyf., an organisation assisting disabled and disadvantaged people; a bridge of 1820 built of dressed Penmon limestone crossing the Cegin river; the office (1840s); a circular privy (1862); the two-road locomotive shed (1878); and the shed for the quarrymen's train (1880).

Figure 2.20. The Neo-classical office at Port Penrhyn dates from the 1840s.

Figure 2.21. Port Penrhyn is a well-preserved industrial port built between 1790 and 1855.

Element 1.5 Mynydd Llandygai Settlement

An area set aside by the Penrhyn Estate for planned housing for quarrymen and their families, developed from the 1820s to the 1860s, with cottages set in long garden plots.

The Penrhyn Estate sponsored its own model settlement for quarrymen on the exposed slopes of Mynydd Llandygai, on the western sides of the Ogwen River. In 1796 the lower slopes were enclosed as a potato-patch to feed the quarrymen and their families; the upper slopes were initially exploited as a peat-digging to provide fuel for their homes. The first houses were built in 1798 alongside the slate road from the quarry, and have mostly been replaced with late-nineteenth century dwellings for quarry officials. On the mountain, quarrymen's dwellings on the lower road, Llwybr Main ['back path'], were laid out in 1843 and on the higher, Tan y Bwlch, in 1862. These are half-lofted dwellings of traditional design, each with a long garden on the hillside set out in regular order. Adapted former places of worship here include the Congregational (Independent) 'Hermon' chapel, built in 1845, rebuilt in 1856 and again in 1879, to a sub-classical design by the architect Owen Morris Roberts of Porthmadog, and the Methodist 'Amana' chapel, built in 1868 in the simple round-headed gable entry type. The spire of St Anne's (Anglican) church, built in the early English style in 1865, is a prominent feature, to remind those who lived there of the important and enduring role of the established state church.

Figure 2.23. Tan y Bwlch road on Mynydd Llandygai, with the quarry in the background.

Figure 2.22. Mynydd Llandygai illustrates the dual economy of quarrying and agriculture, and the controlling hand of the Penrhyn estate in the way it housed its workforce in this designed landscape.

Element 1.6 Bethesda Village

Figure 2.24. Bethesda has seen little change since the beginning of the twentieth century, and is still mostly a long settlement on both sides of Telford's historic highway from Shrewsbury in England to Holyhead, a major port on the island of Anglesey.

A village initially created by quarrymen and their families who preferred not to live on the Penrhyn Estate, established on a freehold where the Congregational (Independent) chapel from which it took its name was built in 1820. The earlier, core part is characterised by plain dwellings along Thomas Telford's highway, and a lack of any formal planning. Its subsequent expansion onto estate land includes larger dwellings and community infrastructure sponsored by the Penrhyn family once it recognised this independent community as an established fact.

The earliest part of the village of Bethesda was developed on one of the few parts of the Ogwen Valley that did not form part of the otherwise all-dominant Penrhyn Estate, and was constructed by slate-quarrymen to house themselves and their families. The community takes its name from 'Bethesda Chapel' (Congregational/ Independent) of 1820, built where Thomas Telford's newly-completed government-sponsored highway from Shrewsbury to Holyhead entered an area of freehold. Early settlement was confined to this small independent patch, first as a ribbon development along the road, then along winding field-paths as the population grew in the 1850s.

Fig 2.25. John Street In Bethesda is one of the parts of Bethesda built with 'great contempt for regularity' in the mid-nineteenth century.

Figure 2.26. 'Jerusalem' chapel was remodelled in 1872-5 by a local architect, Richard Davies of Caernarfon.

Bethesda in 1853 '.... its main street, a wide but winding thoroughfare, and the only street, properly so called, in the whole village. The rest of the houses were built all around, with great contempt for regularity: each house was built wherever a patch of tolerably level ground could be found facing any point of the compass which its builder might fancy. The houses looked as if they had rolled down the mountains with the other boulders, and had been suddenly stopped on their course before they reached the brawling Ogwen below. (Robert Roberts "Sgolor Mawr"' (Roberts 1991, 274)).

This pattern is still evident, but Bethesda also shows the influence of town planning in the more orderly layout of streets and housing following its Improvement Act of 1854 and where it later expanded onto the Penrhyn estate.

Distinctive chapels in the town include the substantial Calvinistic Methodist 'Jerusalem', built in 1842, remodelled in 1872-5, the Welsh Congregational/ Independent 'Bethania' of 1885 and 'Bethesda' itself, a rebuild of 1872-5, contrasting with the Early Decorated design of the Anglican Christ Church/Glanogwen of 1855-6. Most of the houses, shops and public houses in Bethesda date from the second half of the nineteenth century.

Bethesda has seen little development since the prolonged and bitter strike (1900-1903) at Penrhyn Slate Quarry. This is still the longest running labour dispute in the history of the United Kingdom, pitching progressive and conservative forces against each other across the nation, and marking the beginning of the industry's long twentieth-century decline. Bethesda remains an excellent example of a Victorian industrial community.

Figure 2.27. Gordon Terrace (Rhes Gordon), built in 1885, is an example of later-nineteenth century housing for the better-off inhabitants of Bethesda.

Figure 2.28. The cottage row Cae'r Berllan, on the outskirts of Bethesda, probably dates from the 1830s.

Element 1.7 Penrhyn Castle and Park

The extravagant neo-Norman dwelling of the Penrhyn family, built by the architect Thomas Hopper from the early 1820s to 1837 on the site of much earlier dwellings, set within an enclosed nineteenth century landscape park with terraced garden, walled kitchen gardens and lawns.

Penrhyn Castle was the North Wales home of the family that owned both the quarry and most of the land in the Ogwen Valley, as well as extensive estates in England and in Jamaica. There has been a high-status dwelling here since at least the fourteenth century, successively re-built to culminate in the present Neo-Norman fantasy castle by Thomas Hopper, completed in 1837. It is one of the most lavish houses in Britain, rising out of the parkland woods to dominate a wide surrounding area, and

Penrhyn Castle – 'Continental travellers along the Holyhead road marvelled at the British and their political economy, which enabled a commoner to erect a palace for a king.' (Haslam, Orbach and Voelcker 403).

exemplifies the money that could be made from, and invested in, the slate industry of North Wales. Its opulence contrasts with the dwellings of the quarrymen and their families (Elements 1.5 and 1.6).

An area of 300 hectares around the Castle was transformed into a purely ornamental landscape, symbolically sealed off by a high boundary wall topped with broken Penrhyn slate, on which work commenced in 1819. The Penrhyn Slate Quarry Railroad to the west became the park boundary. The terraced garden, walled kitchen gardens and lawns retain their nineteenth century character, as well as their setting and their strong visual relationship with the Castle and the surrounding landscape.

Figure 2.29. The size and extent both of Penrhyn Castle and its park are apparent in this aerial view.

Summary of values and attributes

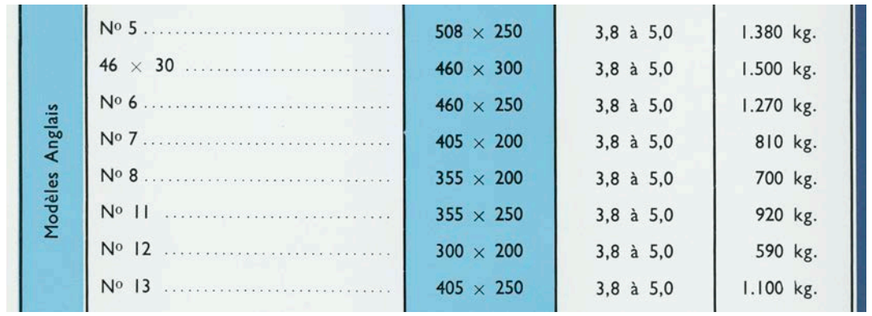
As the first area of the slate industry of North Wales to be extensively capitalised for global markets, the Ogwen Valley demonstrates how quarrying was re-organised by a single, immensely wealthy family, as a major part of a broader investment in their great landed estates. This transformative process reflects the reinvestment of profits from their sugar plantations in Jamaica, financial links to the maritime mercantile city of Liverpool, and the family's strong political connections in London. It illustrates the mixture of landed and banking capital in the British Industrial Revolution, as well as the role of British slavery as a source of funding for industrial development.

These changes began in the last decades of the eighteenth century and in the early years of the nineteenth, when Richard Pennant (Lord Penrhyn) cancelled the leases held by local partnerships which had previously conferred the right to work scattered and small-scale diggings, and instead initiated intense and systematised operations concentrated on the major slate vein in the valley. His engineers developed a system of regular stepped benches or 'galleries' to work the rock-face, and greatly improved transport links to the coast. He had created the world's largest single slate quarry by the early nineteenth century.

The wealth available to Lord Penrhyn and his successors is evident not only in the form and scale of the workings, but also in improved capacity. Innovative technologies include the first slate-slab mill in the industry (by 1802) and the iron railroad connecting the quarry to the sea (1801). The site is also remarkable for its rare variety of surviving water-driven machinery. Outside the Nominated Property, Penrhyn Quarry has continued to introduce new methods to the present day, and remains in active production. It is the one remaining quarry within the slate industry of North Wales where traditional techniques of extracting the rock and splitting blocks are still carried out on an industrial scale.

Other slate-producing areas in the region sought to emulate the technologies introduced at Penrhyn Slate Quarry and its novel transport systems.

Penrhyn slates were sold as 'Bangor blues', named after the town adjacent to the harbour at Port Penrhyn from which they were shipped. A set of standard sizes was established in the late eighteenth century by the architect and slate- and timber-merchant James Wyatt (1746-1813). It was subsequently adopted by the building industry. *Modèles Anglais* ('English [sic] sizes') were also offered by the slate quarrying industry of France.



Modèles Anglais				
	N° 5	508 × 250	3,8 à 5,0	1.380 kg.
	46 × 30	460 × 300	3,8 à 5,0	1.500 kg.
	N° 6	460 × 250	3,8 à 5,0	1.270 kg.
	N° 7	405 × 200	3,8 à 5,0	810 kg.
	N° 8	355 × 200	3,8 à 5,0	700 kg.
	N° 11	355 × 250	3,8 à 5,0	920 kg.
	N° 12	300 × 200	3,8 à 5,0	590 kg.
	N° 13	405 × 250	3,8 à 5,0	1.100 kg.

Figure 2.30. French slate quarries have offered 'modèles Anglais' based on the Penrhyn Slate Quarry standard sizes since the mid-nineteenth century.

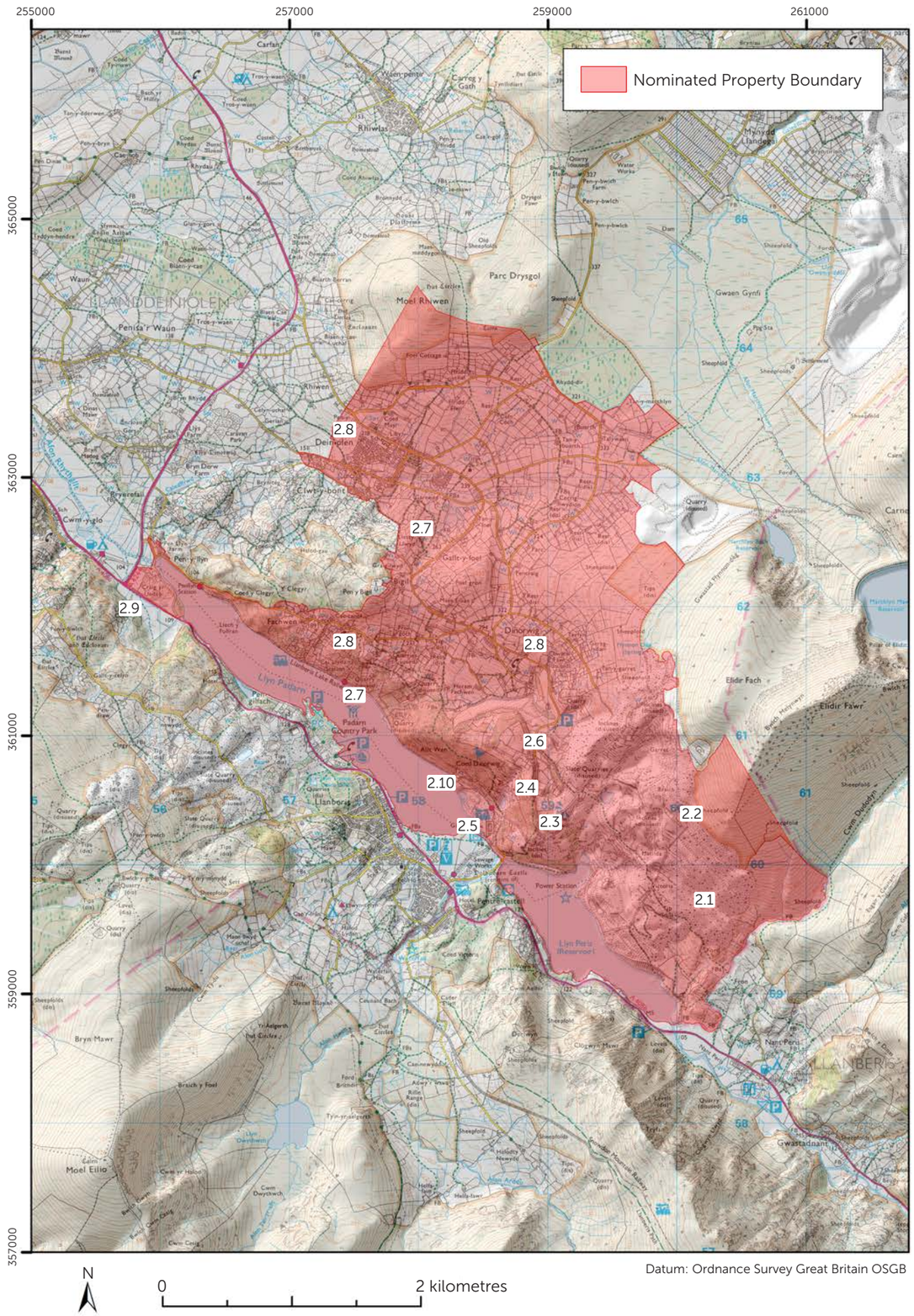
Table 2.2. The standard sizes established at Penrhyn Slate Quarry were adopted throughout the industry

Empresses	660.4mm X 406.4mm (26" X 16")
Small Empresses	660.4mm X 381mm (26" X 15")
Queens	609.6mm, 660.4mm, 711.2mm, 762mm, 812.8mm, 863.6mm (24", 26", 28", 30", 32" and 34") long and various breadths
Princesses	609.6mm X 355.6mm (24" X 14")
Duchesses	609.6mm X 304.8mm (24" X 12")
Small Duchesses	558.8mm X 304.8mm (22" X 12")
Marchionesses	558.8mm X 279.4mm (22" X 11")
Countesses	508mm X 254mm (20" X 10")
Wide Countesses	457.2mm X 254mm (18" X 10")
Viscountesses	457.2mm X 228.6mm (18" X 9")
Wide Ladies	406.4mm X 254mm (16" X 10")
Broad Ladies	482.6mm X 228.6mm (19" X 9")
Long Ladies	419.1mm X 215.9mm (16½" X 8½")
Ladies	406.4mm X 203.2mm (16" X 8")
Wide Headers	355.6mm X 304.8mm (14" X 12")
Small Headers	330.2mm X 254mm (13" X 10")
Small Ladies	355.6mm X 203.2mm (14" X 8")
Narrow Ladies	355.6mm X 177.8mm (14" X 7")
Doubles	330.2mm X 177.8mm (13" X 7")
Wide Doubles	304.8mm X 203.2mm (12" X 8")
Small Doubles	304.8mm X 152.4mm (12" X 6")
Singles	254mm X 203.2mm (10" X 8")

Quarry settlements in the Ogwen Valley exemplify the social tensions caused by the controlling hand of the estate, itself a reflection of its use of coerced labour in the West Indies. The stylised cottages and houses built by the estate contrast with the plainer dwellings which independent-minded quarrymen created for themselves on freehold land. Anglican churches with tall spires vie with the 'preaching barn' architectural style of the Nonconformist chapels.

COMPONENT PART 2
Dinorwig Slate Quarry Mountain Landscape

Figure 2.31. The stepped galleries of the Dinorwig Slate Quarry are cut into the slopes of Elidir Fawr mountain. Between the two lakes at the foot of the quarry, the quadrangular yard of the National Slate Museum is evident. This was once the quarry's engineering complex.



Map 2.3. The boundary and Elements of Component Part 2: Dinorwig Slate Quarry Mountain Landscape (Scale 1:40,000).

Location and setting

The Dinorwig area is the second-most northerly of the Component Parts, a sub-rectangular southeast-northwest trending area that is around 5.5km at its longest, and typically around 3km wide; in the vicinity of the Quarry, the landscape takes in a dramatic rise in elevation of 600m. The orientation of the Component Part is aligned with the topography of the mountainside (in which the slate deposit is located) and the valley floor, which is largely occupied by two long and narrow lakes. The Quarry is located on the southern side of the Elidir Fawr mountain (924m above sea level), which separates it from Penrhyn Slate Quarry by around 5km; it also lies at the foot of Snowdon, the highest mountain in Wales and England (summit 1,085m above sea level, 4.5km to the south). All elements are intimately related in their direct development by aristocratic owners, and the strongly engineered approach to quarrying for slate that their resources made possible, as well as the social tensions between them and the workforce.

The Quarry was only slightly smaller in area and output than Penrhyn (Component Part 1) and covers more than 2.8km^2. From the smaller (Peris) of two lakes, stepped galleries (two principal sections with over 30 galleries in each) and their cascading tips of waste rock soar to an elevation of 500m up the side of the dissected mountain. 'Stairways' of some twelve massive, slate-built inclined planes connect galleries to produce, overall, a dramatic icon of Welsh slate.

The slate formation is Cambrian, part of the Arfon Slate District that also includes the quarries in Component Parts 1 and 3. Dinorwig lies within a geological fault that has produced a northwest-southeast trending pronounced upland valley (Nant Peris) with two narrow and contiguous lakes, Peris (1.6km long, below the Quarry) and Padarn (3km long), between which stands the thirteenth-century Dolbadarn Castle, built by the Welsh prince Llywelyn ab Iorwerth. The industrial landscape of Dinorwig Slate Quarry is particularly evident looking eastwards towards Elidir Mountain from the road which follows the Nant Peris valley (the A4086). To the immediate southeast is the narrow, straight and steep-sided Llanberis Pass, between the Snowdon massif and the Glyderau mountain range. The doorway and service buildings of the underground pumped-storage hydro-electric power station, constructed between 1975 and 1984, are visible on the lakeside level of the Quarry.

The highest elevations of quarried landscape in their rugged mountain setting give way to a sparsely settled rural upland in the north and northwest. Here, dispersed quarry workers' cottages and smallholdings, and small nucleated villages provide a settlement pattern that, together with barracks in the immediate vicinity of the Quarry itself, demonstrates the subtler impact the industry made on the pre-existing rural scene.

The Dinorwig landscape has appealed to travellers and artists searching for the Romantic and the Sublime, and has also attracted mountain climbers and botanists since the eighteenth century.

Summary

Includes the great Dinorwig Slate Quarry with its stepped galleries, tips of waste rock and processing areas rising 500m from the valley floor and its twin lakes, impressive quadrangular former Dinorwig Slate Quarry Engineering Complex (now the National Slate Museum), an innovative hospital to treat injured quarrymen, extensive worker settlements including barracks, dispersed cottages and the nucleated villages of Deiniolen and Clwt y Bont, and transport systems by lake, road and railway.

Elements

Elements of this Component Part date from the 1780s to the 1920s within a mountainous landscape of aristocratic improvement.

Table 2.3 Component Part 2 Elements

Element 2.1	Dinorwig Slate Quarry
Element 2.2	'Australia' Gallery
Element 2.3	Anglesey Barracks
Element 2.4	V2 Inclined Plane / Vivian Slate Quarry
Element 2.5	Dinorwig Slate Quarry Engineering Complex. The National Slate Museum
Element 2.6	Dinorwig Slate Quarry Road Systems
Element 2.7	Dinorwig Slate Quarry Railroad and Railway
Element 2.8	Deiniolen, Clwt y Bont, Dinorwig and Fachwen Settlements
Element 2.9	Craig yr Undeb ['Union Rock']
Element 2.10	Dinorwig Slate Quarry Hospital

Element 2.1 Dinorwig Slate Quarry

Figure 2.32. Dinorwig Slate Quarry is reflected in the waters of Peris Lake. The massive system of inclined planes shows how these transport systems made ingenious use of topography to ensure internal movement of slate rock. Locomotive-worked railway systems ran along each of the stepped galleries to the massive tips of waste rock.

An extensive relict slate quarry, once the second largest in the world, worked intensively from 1787 to 1969 and which retains substantial structures and machinery. Dinorwig adopted the same system introduced at Penrhyn Slate Quarry, of stepped galleries, along the west-facing slopes of Elidir Fawr Mountain, overlooking Peris Lake. These galleries lead to extensive areas of tipping to the north and south of the vein. Inclined planes, including massive four-track rubble-walled examples, represent striking features of this monolithic industrial system.

A slate quarry worked in over thirty stepped galleries, each with its tip of slate waste, connected by two major systems of inclined planes from the highest galleries to the lakeside floor. Slate mills, a transformer house, and slate-splitters' shelters survive, as well as substantial machinery on the upper galleries (see Element 2.2 'Australia' Gallery), and a row of barracks for quarrymen who lodged by the week, which has been conserved (see Element 2.3 Anglesey Barracks).

The intact 'A' series of inclined planes, built in 1869-1870 to connect the upper quarry to the railway, remained in use until the quarry's closure in 1969. Many have preserved their drum-houses, rails and other ironwork.

Figure 2.33. The 'A' series inclined planes are impressive features within the quarry landform. In many cases, machinery survives as well as well as the embankments on which they are built.

Figure 2.34. Some inclined planes were built on very steep gradients indeed, and used traveller carriages to transport the wagons.

Element 2.2 'Australia' Gallery

'Australia' Gallery, with its slate mill from the 1920s, is spectacularly situated towards the top of the south-eastern (Braich) side of the Quarry; at an elevation of 480m, this element is remote and difficult to access, hence the mill avoided having its machinery removed for scrap and thus survives remarkably intact.

The upper stepped galleries of Dinorwig Slate Quarry retain machinery that reflects technology dating from the mid-nineteenth century to the 1930s. The 'Australia' Gallery is situated at 702m AOD. Long known as 'Braich' ['arm (of the mountain)'], it acquired its present name with the declaration of the Commonwealth in 1901, reflecting quarrymen's interest in current affairs. The inclined plane to the higher gallery was built *c.* 1889.

The mill is built of slate rubble and on a very long rectangular plan (100m x 15m) with end-gables entered by railways. Regularly spaced open doorways gave access to a lean-to along a terrace (approximately 200m x 25m), which is retained by rubble walls on the down-slope front and sides. Construction dates from 1922-4, the period when the quarry extended its electricity supply. The adjacent compressors, water-tank and water-supply system and electric motor illustrate the adoption of pneumatic drilling, while the railway system, with its varieties of inclined plane and its locomotive shed, provide an excellent example of how this distinctive technology operated within the extractive and tipping areas of a galleried slate quarry. A *caban* survives here, the shelter where the men met to eat during their breaks from work and to engage in formal discussions.

Figure 2.36. The mill was built in the 1920s and preserves its rows of 36 saw-tables (right), as well as separate working spaces for hand-splitting, contrasting with the un-mechanised *gwaliau* [slate-splitters' shelters] in the Vivian Slate Quarry.

Figure 2.35. The upper galleries of Dinorwig Slate Quarry (above) were left untouched when it closed in 1969. The 'Australia' Gallery mill and other features are apparent in this aerial view.

Element 2.3 Anglesey Barracks

The Anglesey barracks, *y dre' newydd* ['the new town'], were built in the early 1870s adjacent to the former operational area of Dinorwig Slate Quarry, for workmen who lived too far away to commute daily.

Workmen from Anglesey or from elsewhere in the region lodged here on a weekly basis (a bedroom in each unit had space for four men) until 1937, when the Barracks were condemned as unfit for human habitation. The two rows of identical blocks of 11 two-roomed cottages, with windows only facing inwardly onto the 'street', differ little from vernacular cottage dwellings of the period, and are the last survivors of the seven or so barracks known to have functioned at the Quarry. Together with scattered cottages on the uplands to the northwest of the Quarry (Element 2.8), such barracks further illustrate how much-needed accommodation was provided for the workforce of up to 3,000 men, in a Component Part that exemplifies the hostile environment faced by the mountain slate-worker.

Figure 2.37. The Anglesey barracks are built on a 65x15m footprint, partly on a terrace made up of waste rock. The doorway through the wall at the eastern end is 8m from an inclined plane. Other, more ruinous, barracks are evident to their right. See also Figure 2.8.

Element 2.4 V2 Inclined Plane/Vivian Slate Quarry

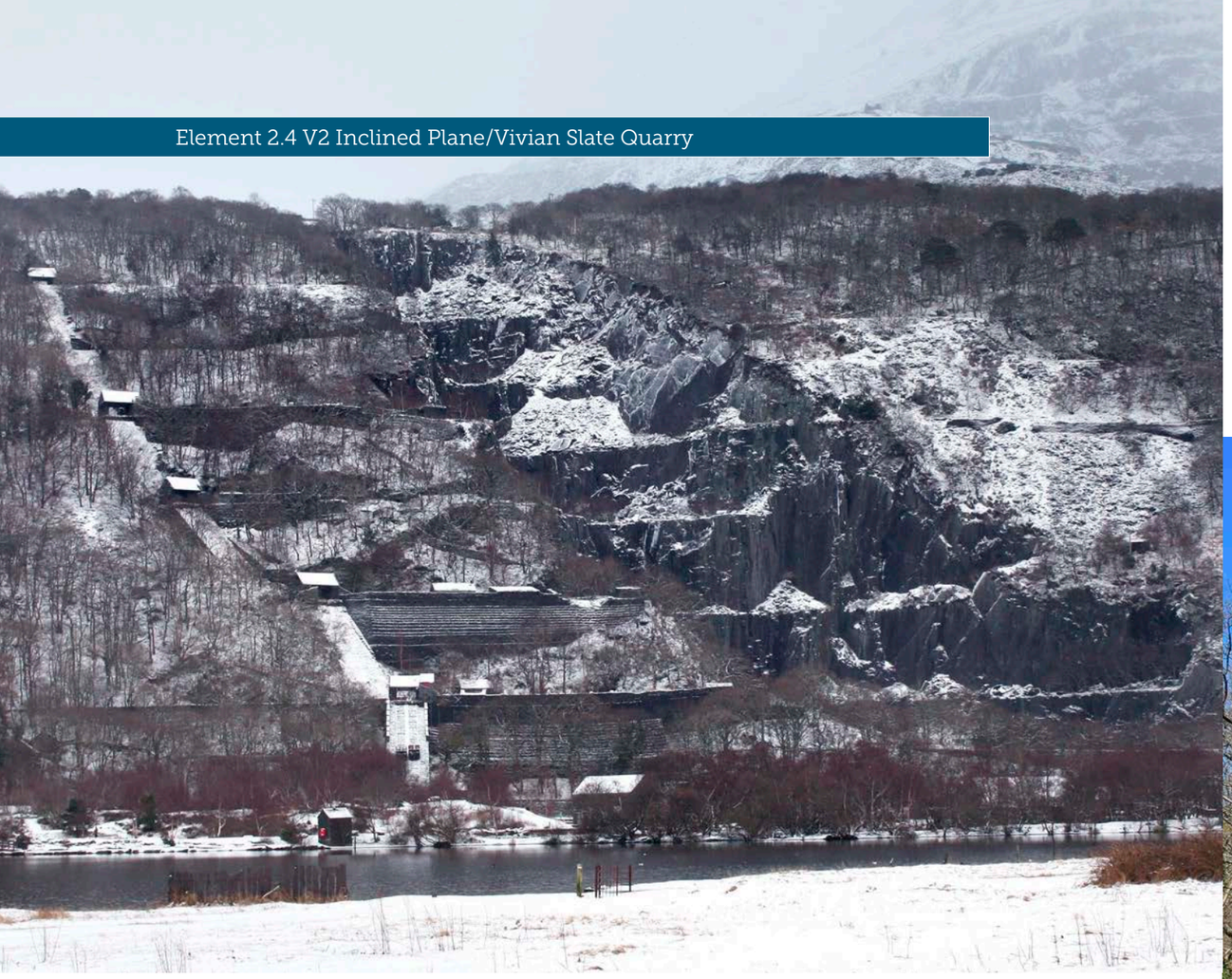


Figure 2.38. A fall of snow has brought out the galleries in the Vivian Slate Quarry and its system of inclined planes.

The Vivian Slate Quarry was a separate department of the Dinorwig complex, and preserves on a smaller scale many of the attributes of the Dinorwig Slate Quarry as a whole. There were eight different floors worked on the gallery system. A preserved and restored 'transporter' (also known as 'platform' or 'tank') inclined plane, powered today by an electric motor, is the last working example of a traditional inclined plane in Wales, one of over 500 counterbalanced inclines that once served the Welsh slate industry. An aerial ropeway has also been conserved. Adjacent to the head of the incline is a well-preserved row of *gwaliau*, the shelters where quarrymen processed and split the raw blocks of slate with hand-tools.

The Vivian Slate Quarry was opened out from the 1860s adjacent to what is now the National Slate Museum on the same principle of stepped galleries as the main Dinorwig complex, of which it formed a separate department. Rows of shelters on each gallery housed the slate-makers, representing the essential principles of this type of working. Several examples have been conserved. Inclined planes were built to the north of the wedge-shaped quarry to transport the finished slate to the railhead. One of these, the V(ivian)2, was conserved and returned to working order in 1998-9 by the National Museum of Wales, and is of a distinctive design in which the quarry trucks are carried on transporter carriages to facilitate operation. An aerial ropeway and its electric motor dating from the 1920s have also been conserved.

The site has public access along footpaths as part of the Padarn Country Park, which is managed by Gwynedd Council. The incline is operated by Museum staff for demonstration purposes.

Figure 2.39. The V2 inclined plane, conserved and returned to working order in 1998-9, demonstrates the operation of this typical slate quarry technology.

Element 2.5 Dinorwig Slate Quarry Engineering Complex.
The National Slate Museum

Figure 2.40. The Quarry supported a host of ancillary industries. Its former engineering complex includes a slate mill, locomotive sheds, repair facilities for machinery, and a foundry. This massive quadrangular range of workshops and other buildings was constructed in 1870 on bedrock and slate waste. The elaborate, yet functional, façade shows access for the narrower quarry gauge railway, and the broader gauge Dinorwig Quarry Railway that transported slate to the sea. Traditional skills were taught to apprentices and were handed down over the generations. Functioning today as the National Slate Museum, the complex has been sensitively conserved.

The former Dinorwig Slate Quarry engineering complex at Gilfach Ddu (now the National Slate Museum) is a quadrangular range of ancillary workshops built around a central courtyard. Here much of the Quarry's machinery was built and maintained. It changed little from when it opened in 1870 until it closed nearly a hundred years later.

The architecture of the complex is ambitious, and is unusual in the context of the slate industry of North Wales. The quadrangle design recalls both the stable-courtyard of country houses and early industrial practice.

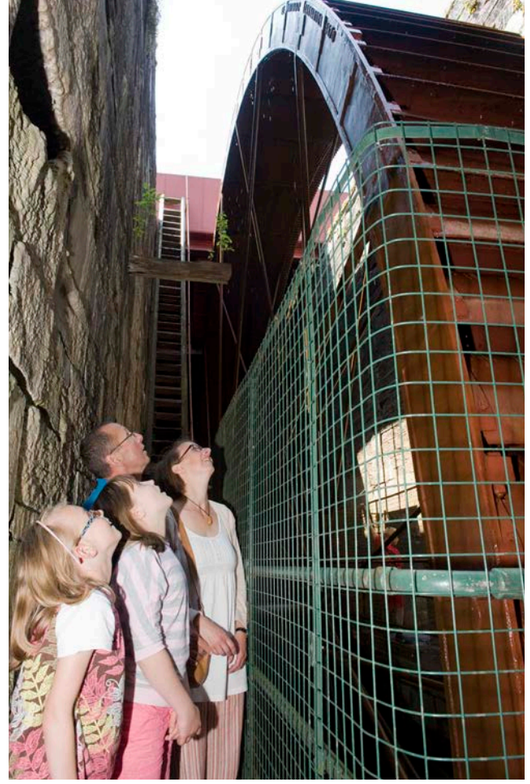


Figure 2.41. Public access to the iron waterwheel enables visitors to understand the skilful use the slate quarries of Northwest Wales made of their extensive water catchment areas.

Figure 2.42. The 1926 Pelton (bottom right) is directly coupled to the line-shafting in the Museum and provides a contrast with the earlier technology which it replaced.

The 15.4m-diameter iron suspension waterwheel, now the largest operational example in mainland Britain (located in a massive waterwheel housing at its southwest corner, near where the two lakes are divided) powered the Dinorwig Slate Quarry Engineering Complex, and was built by a local engineering firm. It was conserved and returned to working order in 1998-9, and is the largest surviving waterwheel in mainland Britain. A Pelton wheel from 1926 now operates the machinery. The historic machinery and the foundry survive, and the site as a whole is a time-capsule of mid-Victorian British engineering practice.

The National Slate Museum is housed in the former Dinorwig Slate Quarry engineering complex, once the main maintenance hub of the quarry. It is located in a piece of made-up ground on the shores of Padarn Lake, at the foot of the 'A' series of inclined planes from the quarry, and adjacent to the Vivian Slate Quarry, and the Dinorwig Slate Quarry Hospital.

One quadrant of the engineering complex houses the steam locomotives and repair facilities for the Llanberis Lake Railway, which has been operated on the trackbed of part of the Dinorwig Quarry Railway since 1971. Nearby is a relocated and reconstructed winding engine house from within the Quarry.

As the National Slate Museum, a part of Amgueddfa Cymru/National Museum Wales, the site interprets the history of the slate industry of Wales, offering talks, lectures and demonstrations of slate-splitting. Relocated quarry dwellings on the site depict the living conditions of quarry workers and their families during the boom period in 1861, during the time of the long-running labour dispute at Penrhyn Slate Quarry in 1900-1903, and after the sudden closure of Dinorwig Slate Quarry in 1969.

Element 2.6 Dinorwig Slate Quarry Road Systems

Figure 2.43. Penllyn bridge at the north-eastern end of Padarn Lake.

Early road systems developed at the Quarry include the 'drag' to the lake, the slate roads through Deiniolen village and to the 'Garret' (the higher galleries of the quarry), and the road from a small quarry on the Fachwen slopes to the north-eastern end of Padarn lake and a bridge.

Early routes built to transport the slate from Dinorwig Slate Quarry include the eighteenth-century 'drag' cart-road, now bisected by the workings of the Vivian Slate Quarry, to a landing point on the shore of Padarn Lake, buried but adjacent to the Dinorwig former engineering complex, and a more ambitious road which led to a tidal harbour on the Menai Straits. Its branch to the upper or 'Garret' part of the quarry was laid out in 1823 by the renowned engineer William Alexander Provis. Other features include the fine four-arched bridge of 1826 at the north-eastern end of Padarn Lake on the Fachwen road, built by the skilled local contractor John Hughes.

Figure 2.44. The uppermost road here led to the upper 'Garret' galleries in the quarry. It was designed and built by Thomas Telford's assistant William Alexander Provis in the 1820s, part of the pre-railway network that transported Dinorwig slates to the sea. It makes its way through the small plots of land leased to quarry families to provide for themselves by building homes and growing food.

Element 2.7 Dinorwig Slate Quarry Railroad and Railway

The 0.6-metre-gauge Dinorwig Slate Quarry Railroad of 1825, based closely on the design of the Penrhyn Slate Quarry Railroad (Element 1.3) and the 1.2192-metre-gauge Dinorwig Slate Quarry Railway of 1842, two successive railed slate transport systems.

The original 0.6-metre-gauge iron railroad of 1825 used horse traction along lightly graded sections and counterbalanced inclines to connect the quarry with a tidal harbour on the Menai Straits to the north. It adopted the cast-iron rail technology of the Penrhyn Slate Quarry Railroad of 1801 (Element 1.3), even though this technology was on the point of being superseded. It was replaced in the 1840s by a more ambitious system, the upper section of which ran along the shore of Padarn Lake, designed by engineers who had worked with both Robert Stephenson and Isambard Kingdom Brunel. It was operational until 1961, and the part along the lake was rebuilt as a tourist railway in 1971.

Figure 2.45. Both the slate road through the village of Deiniolen and the 1825 Dinorwig Slate Quarry Railroad are evident in this aerial view. The Railroad can be traced as a tree-grown formation making its way down the slope on the right of the photograph.

Figure 2.46. Here the 1825 Dinorwig Slate Quarry Railroad is evident as a lane in the village of Clwt y Bont.

Figure 2.47. The Dinorwig Slate Quarry Railway closed in 1961, and a tourist railway using shunting locomotives from the quarry was laid on part of the formation.

Element 2.8 Deiniolen, Clwt y Bont, Dinorwig and Fachwen Settlements

These different types of settlement illustrate the variety of ways in which the demand for housing was met, and how transport needs and land-ownership patterns shaped them.

The Vaynol estate secured permission from Parliament to enclose the Dinorwig mountain common land in 1806. The estate leased plots of land here and on the Fachwen slopes for quarrymen and their families to build their own dwellings. Many are now abandoned. Even in ruins, they show how the influx of workers into the slate industry moved the margins of cultivation almost to the summits of the hill-slopes. By contrast, quarrymen who yearned for independence established the adjacent nucleated villages of Deiniolen and Clwt y Bont on small freeholds, with the help of speculative contractors and local building societies. Deiniolen was built along the slate road from the quarry to the sea, Clwt y Bont along the course of the 1825 quarry railroad.

The location of Anglican churches and nonconformist chapels, and their different architectural styles, also indicate the social forces competing for the allegiance of the quarrymen and their families. The Gothic-revival church and the Lombardic Methodist chapel on the moors immediately to the southeast of the village exemplify the rivalry between the Established (Anglican) church and the Dissenting denominations, vying for souls in an inhospitable landscape.

Figure 2.49. Rhes Fawr ['the big row'] is the work of an Anglesey builder, David Griffith, in the 1830s. He bankrupted himself building them. They originally only had two rooms.

Figure 2.48. This view shows estate-sponsored plots of land and cottages, the independent freehold villages of Deiniolen and Clwt y Bont and twentieth century social housing.

Element 2.9 Craig yr Undeb ['Union Rock']

This natural rock outcrop is where the North Wales Quarrymen's Union held its meetings. It represents a significant monument to the history of labour organisation and trade unionism in the Welsh slate industry.

Conflict between quarrymen and quarry-owners is evident at Craig yr Undeb ['Union Rock'], a natural outcrop at the north-western end of Llyn Padarn, where meetings of the North Wales Quarrymen's Union were held.

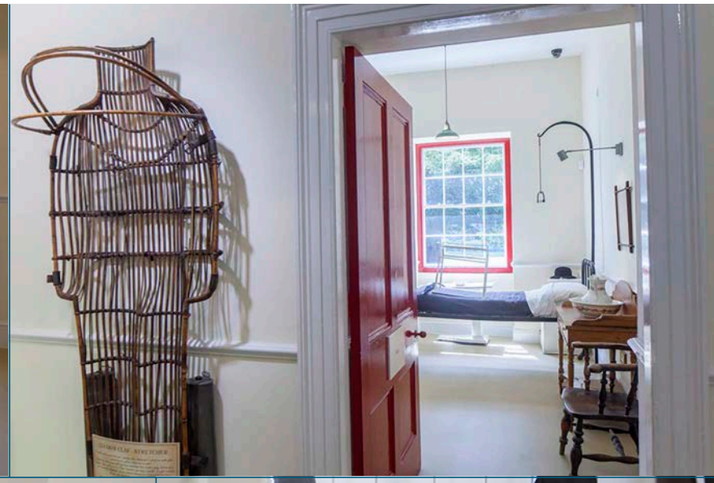
Figure 2.50. This view from Craig yr Undeb shows Padarn Lake, with Dinorwig Slate Quarry and Snowdon in the distance. It had been the traditional meeting place for local slate quarrymen long before the Union was proclaimed in 1874. Nonconformist quarrymen's Old Testament sense of themselves as the prophets of the new Israel led them seek out high places for their meetings and for their deunciations of the oppressor – more prosaically, Craig yr Undeb did not belong to the quarry-owner and so they could not be prevented from meeting there.

Element 2.10 Dinorwig Slate Quarry Hospital

Dinorwig Slate Quarry Hospital is one of the three hospitals established in the Welsh slate industry, all of which are included in the Nominated Property. Industrial hospitals are relatively rare in Britain and this particularly innovative example was built in the early 1860s.

Dinorwig Slate Quarry was the scene of horrific accidents in the early nineteenth century, but by the 1890s was hailed as a model of good practice. Dinorwig Slate Quarry Hospital is a rare surviving example of a nineteenth-century British industrial hospital which survives in its entirety, little changed from when it was opened. It is also known for its early use of Rontgen's X-ray technology, from 12 May 1897, when a quarryman thought to be suffering from a tubercular knee was examined. The Dinorwig Hospital is open to the public as a museum, run by Gwynedd Council.

Much of its early medical equipment is on display, and is interpreted.



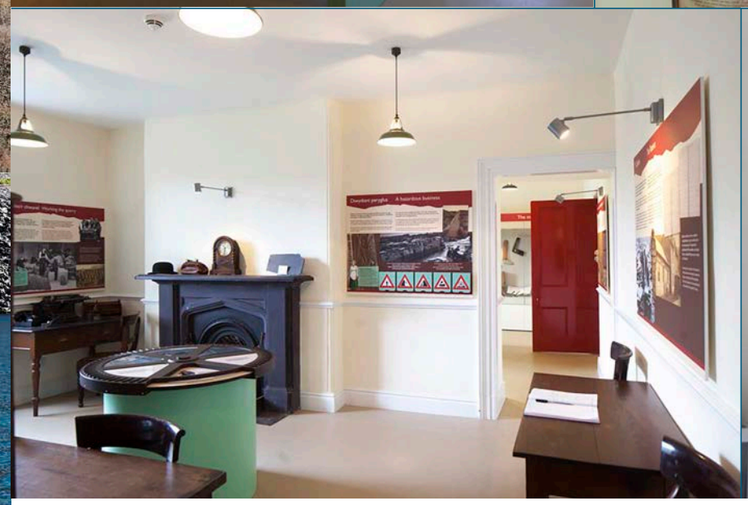


Figure 2.52. Dinorwig Slate Quarry Hospital has been conserved, and opened to the public as a museum with much of its early medical equipment on display.

Figure 2.51. Like its counterparts at Penrhyn Slate Quarry (Component Part 1), and in the town of Blaenau Ffestiniog (Component Part 5), the Dinorwig Slate Quarry Hospital layout is based on a central reception block with wings radiating from the gable ends. Each of the three industrial hospitals was built by the principal landowner, and is included in the Nominated Property. The Penrhyn hospital is a ruin, and the Ffestiniog hospital is a private house. Dinorwig Hospital is prominently located so that no-one could miss the benign intent of the owning estate.

Summary of values and attributes

This Component Part is dominated by the spectacular relict galleried rock-faces, inclined planes and tips of the Dinorwig Slate Quarry, within the stunning landscape, at once rugged and picturesque, of the lower slopes of Snowdon and Elidir Fawr, and the two lakes, Peris and Padarn. Like Penrhyn Slate Quarry, Dinorwig was developed by an aristocratic dynasty (the Assheton Smiths, later the Duff family) who were also committed improvers of their estate. Dinorwig Slate Quarry rivalled Penrhyn in size and output and emulated it in many respects but developed a strongly engineered approach of its own, reflected in the first steam railway in the slate industry of North Wales, influenced by both Stephensonian practice and by Brunel, and in the remarkable quadrangular engineering complex of 1870, with its operational water-wheel. The Quarry Hospital, built in the 1860s, was at the forefront of medical care for injured workmen.

The sudden closure of the Quarry in 1969 meant that many buildings, structures and machines survived on some of the higher, more remote galleries. A tourist railway using quarry locomotives along the formation of the former Dinorwig Slate Quarry Railway in 1971, and the opening of the former engineering complex as the North Wales Quarrying Museum (now the National Slate Museum) in 1972, made Dinorwig a major visitor focus. The very visible nature of the workings when viewed from the slopes of Snowdon or across Peris Lake bring home the form and extent of the quarry, and the construction of a major pumped storage scheme in the lower part of the quarry from 1975 to 1984 added to the sense of the 'engineering sublime'.

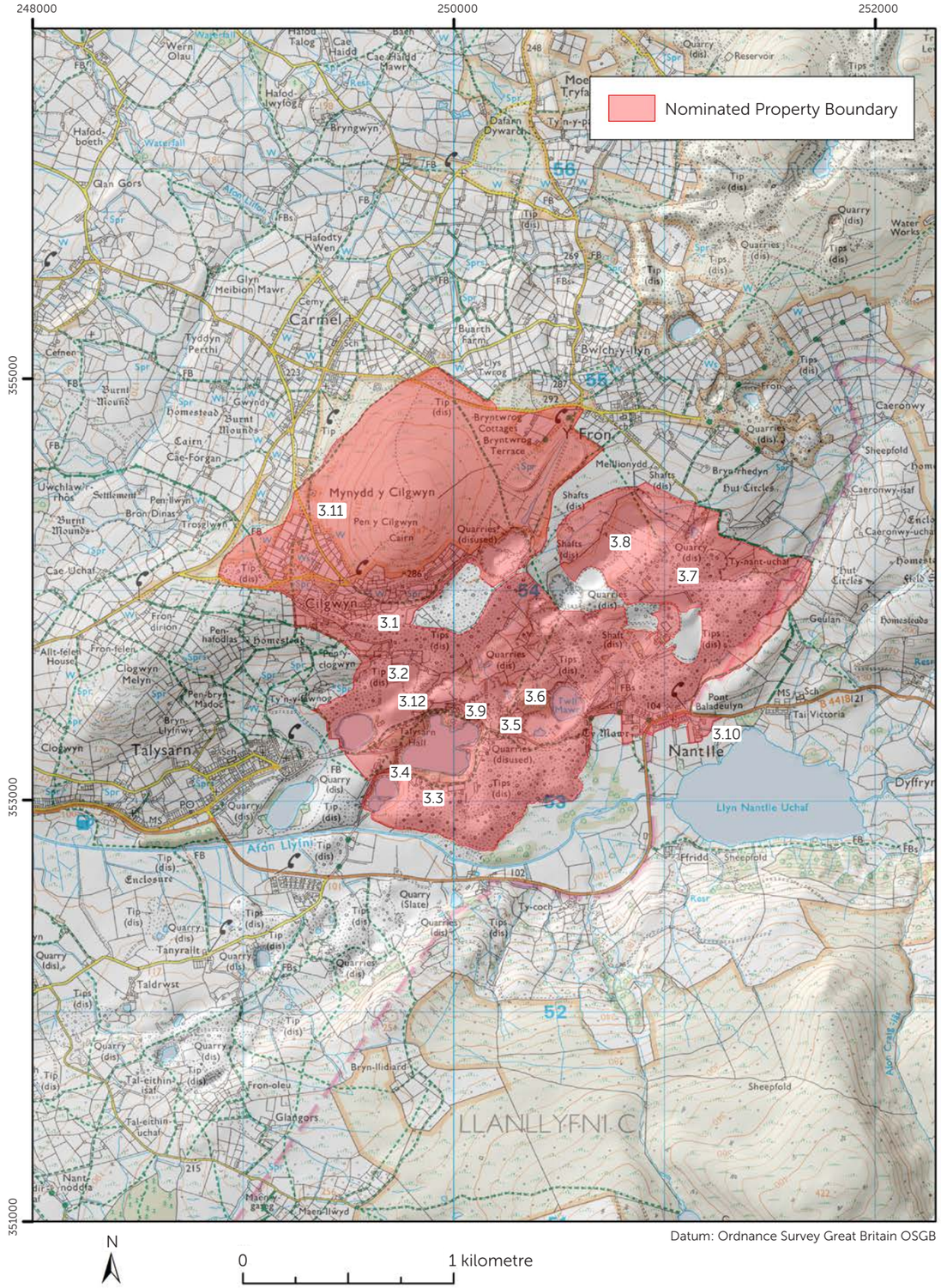
Dinorwig offers a text-book explanation of slate-quarrying practice from the late eighteenth century to the 1960s.

Figure 2.53. This aerial view, looking southeast up the narrow and steep-sided Llanberis Pass, shows the Dinowrig Slate Quarry in its mountain landscape, between the Snowdon massif on the right and the Glyderau mountain range on the left.

COMPONENT PART 3

Nantlle Valley Slate Quarry Landscape

Figure 2.54. This view looking northeast over the Nantlle Valley shows the distinctive pattern of pits on the valley sides and floor.



Map 2.4. The boundary and Elements of Component Part 3: Nantlle Valley Slate Quarry Landscape (Scale 1:25,000).

Location and setting

The Nantlle Valley Slate Quarry Landscape is located 10km southwest of Component Part 2 (Dinorwig) and 16km southwest of Component Part 1 (Penrhyn). All three exploited the same Cambrian formation of the Arfon Slate District, but the form and technical attributes of the Nantlle slate quarries are very different.

The valley runs east to west, framing a perspective of Snowdon, the highest mountain in Wales and England, to the east, and offering views over the Irish Sea as far as the Wicklow Mountains, south of Dublin, in Ireland to the west. The summit of Mynydd y Cilgwyn (347m) rises immediately to the north, whilst to the south a narrow belt of rising farmland gives way to the summit (635m) of Mynydd Tal y Mignedd, a peak on the Nantlle Ridge that leads towards Snowdon.

It is a stark landscape, but one of the world's most pristine, compact yet diverse, archaeological complexes of historic slate quarrying, as well as being rich in prehistoric and medieval archaeology. Geology and topography meant that slate had to be won from pits on the valley floor and on the northern slopes, leading to tips of waste rock in confined environments and the characteristic Nantlle aerial ropeway systems. These include the locally-evolved artisanal technology of the steeply-angled 'chain incline' connecting the quarry floor to the processing area, and the imported Scottish technology of the 'Blondin' catenary ropeway spanning the pit (see below).

Small but highly important structures are the slate-makers' shelters built by unemployed quarrymen to re-work the tips of waste rock in times of economic hardship. Landownership in multiple hands (as opposed to Penrhyn [Component Part 1], Dinorwig [Component Part 2], Bryneglwys [Component Part 6]) meant that the slate veins were leased and worked as many separate quarries – there is no 'great house' in, or associated with, this Component Part, though there are several substantial farms and the homes of minor landowners, as well as fields and wooded ridges, providing evidence for the pre-existing rural economy as well as for the way that the slate industry subsequently reshaped the landscape.

The quarries are now relict, and mostly flooded up to the water-table. Their low-lying location limited the use of waterwheels, with the result that steam-power was more important, including the iconic Cornish beam engine of 1904-06 at Dorothea Slate Quarry. The tide of settlement brought about by the expansion of the quarries is evident in the squatter-plots on the mountain common at Cilgwyn, and a more controlled form of housing is evident in the company village of Nantlle. To the southeast of Nantlle village, the Upper Nantlle Lake adds to the valley setting; there was originally a Lower Nantlle Lake (adjoining to the west) but this was drained to protect the deep slate pits from flooding.

Summary

Includes the open-pit slate quarries up to 150m deep, some of which are now flooded, extensive tips, relict processing buildings, a monumental Cornish beam engine for pumping, in its original roofed engine-house, associated worker settlements, including squatters' cottages and adapted agricultural buildings, and transport systems, including the Stephenson-engineered railway.

Elements

Elements of this Component Part date from the seventeenth century to the 1930s.

Table 2.4 Component Part 3 Elements	
Element 3.1	Cilgwyn Slate Quarry Tips
Element 3.2	Blaen y Cae Slate Quarry 'Blondin' Ropeway
Element 3.3	Dorothea Slate Quarry
Element 3.4	Dorothea Slate Quarry Cornish Beam Engine
Element 3.5	Pen y Bryn/Cloddfa'r Lôn Slate Quarry Dwellings, Slate-Mill and Chain Incline Ropeway Bastions
Element 3.6	Pen y Bryn / Cloddfa'r Lôn Slate Quarry Water-Driven Pump System
Element 3.7	Pen yr Orsedd Slate Quarry
Element 3.8	Pen yr Orsedd Slate Quarry 'Blondin' Ropeway
Element 3.9	The Nantlle Railway
Element 3.10	Nantlle Village
Element 3.11	Settlements on Cilgwyn Mountain
Element 3.12	Plas Tal y Sarn and Tal y Sarn Farmhouse

Element 3.1 Cilgwyn Slate Quarry Tips

These landform-scale slate tips are crowned by the unenclosed mountain, and dominate the Nantlle Valley.

Cilgwyn Quarry was the slate industry of Wales' market leader in the early eighteenth century and finally closed in 1956. It is located on the northern slopes of the valley, but its pits have been mainly in-filled. Its main tips of waste rock, however, lie immediately adjacent to the former quarry, an important landform in the Component Part indicative of the scale of the industry. To the northwest, rocky fields and ruined quarryman-cottager settlements spread over Cilgwyn mountain. The western tip follows the contour of the hillside in a bi-angular

Figure 2.55. The eastern tip at Cilgwyn illustrates the problems of removing waste rock in a confined area. A sinuous railway gave access to the tipping ground on the right of the photograph.

Figure 2.56. The western tip at Cilgwyn Slate Quarry looks out over the sea towards Ireland, once one of its principal markets. In the foreground is a slate-makers' shelter, one of many built during the Great Depression of the 1930s to rework slate blocks that had been dumped when times were good.

landform that stretches for over a kilometre. This dominates the valley floor (at a lower elevation by 75m) and provides a fine vantage point for an overview of the Component Part. It retains the tiny shelters where unemployed quarrymen reworked slate waste during the Depression of the 1930s and which convey the manner in which the landscape of the Nantlle slate industry was evolved by its independently minded local population. The tip to the north is reached by a sinuous railway formation.

Element 3.2 Blaen y Cae Slate Quarry 'Blondin' Ropeway

A classic steam-powered aerial ropeway system known as a 'Blondin', named after the famous tightrope walker Charles Blondin. This technology was originally introduced from Scotland and was deployed to raise slate trucks from a confined pit. The principle comprised a number of wire ropes (cables) strung across the working area between masts of timber or steel, with wagons raised or lowered by steam or electric power. The last working examples were at Pen yr Orsedd Slate Quarry in this Component Part (Element 3.8).

Blaen y Cae Quarry worked a distinctive rippled formation which may have been the source of Roman slates found nearby. It was in production again by the 1830s and worked for a further century. Its principal technical attribute is the steam 'Blondin' ropeway system for raising slate out of one of its pits. This was installed *c.* 1910 and survives with wooden masts, landing platforms on the lip of the quarry pit, a railway embankment, wire ropes and sheaves, together with a steam winding engine and drum by Henderson's of King's Works, Aberdeen, Scotland (makers of cranes, cable-ways and hoists). This is the best-preserved example of a characteristic Nantlle technology associated with a steam engine, and provides an instructive contrast with the (earlier) electrically powered installation at the nearby Pen yr Orsedd Slate Quarry (Element 3.8). It illustrates the challenges of raising material from a confined pit, and technology transfer from the Scottish freestone industry.

Figure 2.57. The steam engine that powered the 'Blondin' ropeway at Blaen y Cae Slate Quarry survives *in situ*.

Element 3.3 Dorothea Slate Quarry

Dorothea Slate Quarry is one of the most important and most widely recognised slate quarries within the Nominated Property; its fine Cornish beam engine is also of particular note, and is recognised as an element in its own right. Dorothea began in 1829 when shallow diggings were commenced on the valley floor, eventually amalgamating to form the giant excavation 150 metres deep that is visible today. The quarry ceased operating in 1970, and the pit flooded. It is now a popular venue for divers.

Surviving buildings and structures on site contribute to an extensive and archaeologically-rich industrial landscape. These include slate mills, a locomotive shed, winding houses, the Cornish pump-engine, and the huge slate bastions for the chain incline ropeways used for lifting slate blocks and rubble from the pit, railed inclined planes, the course of the Nantlle Railway, houses, stables and the many locations where, during the Great Depression of the 1930s, impoverished quarrymen reworked slate from waste-tips to sustain a meagre living.

Figure 2.58. Dorothea Slate Quarry is now a rich relict landscape of quarrying. This aerial view shows the main flooded pit (centre).

Element 3.4 Dorothea Slate Quarry Cornish Beam Engine

The Cornish beam engine, still in its original roofed engine house, is emblematic of the already old-fashioned but reliable de-watering technology imported from Cornwall to counteract rapid ingress of water into pits over 150 metres deep that were necessary to exploit the vertical slate vein in the valley floor.

This large (68-inch cylinder) steam pumping engine was manufactured in Camborne, Cornwall (UK) where the production and export of these distinctive machines form part of the Outstanding Universal Value of the *Cornwall and West Devon Mining Landscapes* World Heritage site. It was built by Holman Brothers, one of Cornwall's most famous mining engineering concerns and engine-builders, and was one of the last such engines ever manufactured. The Dorothea engine started work in 1906 and was preserved when it was replaced by an electric pump in 1951. It contrasts with the nearby Pen y Bryn/Cloddfa'r Lôn Slate Quarry water-driven pumping system, also an imported mining technology from Cornwall and West Devon.

Figure 2.59. The Cornish beam engine installed to pump Dorothea Slate Quarry is spectacularly located on a ridge between the main Dorothea pit (right) and a smaller pit to the west (left).

Figure 2.60. The Cornish beam engine is the icon of the Nantlle Valley slate quarry landscape.

Element 3.5 Pen y Bryn/Cloddfa'r Lôn Slate Quarry Dwellings, Slate-Mill and Chain Incline Ropeway Bastions

An industrial and domestic complex which both illustrates the system of working at one of the smaller workings within Component Part 3 and also how the pre-existing farming landscape was adapted for quarry purposes.

The seventeenth-century house at Pen y Bryn formed the centre of a small estate owned by the local Garnons family, who carried out some quarrying on nearby outcrops on their own account, before leasing them out to capitalised partnerships from 1793. They also came to work an early pit known as Cloddfa'r Lôn ['the Roadside Digging']. The landscape around the house was transformed as the industry grew in the nineteenth century. Structures from this period include a centuries-old barn rebuilt as a dwelling to house the influx of new arrivals, a steam-powered mill to saw slate blocks, winding houses for chain incline ropeways, and an inclined plane installed to connect with the Nantlle Railway (Element 3.9).

Figure 2.61. The steam powered mill complex constructed in 1884 to process the slate blocks.

Figure 2.62. The traces of the seventeenth-century barn are evident in the gable of the barracks.

Figure 2.63. The barracks constructed in the 1860s to house the quarrymen and their families. Part of this terrace was adapted from a seventeenth-century barn.

Element 3.6 Pen y Bryn/Cloddfa'r Lôn Quarry Water-Driven Pump System

A waterwheel-powered flat-rod pumping system; this technology was originally devised in continental European mining-fields, but was widely adopted in Cornwall and Devon (UK), from where it was introduced to the Welsh slate industry.

The company operating Pen y Bryn and Cloddfa'r Lôn Slate Quarries from 1836 to 1844 introduced a double reciprocating pumping system operated by wrought-iron flat-rods driven by water-wheels, for which archaeological evidence survives, each running to a set of multi-stage pumps now evident as cast-iron rising mains in the *twll balast* [balance-engine pit] pit to the south as well as a branch to pumps located in a quarry pit to the east. Two wheel-pits, water channels, stone support-piers and cast-iron piping survive. It provides a contrast in technology with the nearby Cornish beam engine used to pump Dorothea Quarry.

Figure 2.65. Changes in direction for the flat-rods were accomplished by angle bobs mounted on stone support-piers.

Figure 2.64. Waterwheels powered the flat-rod pump system at Pen y Bryn, which was installed by mining engineers from the Cornwall and West Devon area around 1840. Two waterwheel pits are evident.

Element 3.7 Pen yr Orsedd Slate Quarry

Figure 2.66. The landform of Pen yr Orsedd Slate Quarry is evident in this view from the south, showing the pits, the processing areas with the mill buildings, and the tips of slate waste dominating the village of Nantlle.

Pen yr Orsedd is an extensive slate quarry which worked a series of pits on the valley slopes from the early nineteenth century to the late twentieth.

Pen yr Orsedd Slate Quarry reflects a mechanised and engineered approach to the quarrying of slate, with its well-ordered mill buildings arranged to take advantage of water-power, and its electrically powered 'Blondin' ropeways on the upper working floor (Element 3.8, the last to cease operation in the Welsh slate industry, in 1979). Its tips dominate the eastern end of the Nantlle Component Part, and the village of Nantlle.

Element 3.8 Pen yr Orsedd Slate Quarry 'Blondin' Ropeway

A set of electrically powered 'Blondin' aerial ropeway systems which served the upper pit at Pen yr Orsedd quarry, contrasting with the Blaen y Cae Slate Quarry steam 'Blondin' (Element 3.2).

'Blondin' ropeways at Pen yr Orsedd were built by Henderson's of Aberdeen (Scotland: UK) in 1906 and worked until 1978; electrically powered, they contrast with the later steam Blondin in Blaen y Cae Slate Quarry. The Bruce Peebles 50 horsepower, three-phase electric motors operated on the drum through reduction gearing, powered from a remote hydro-electric station.

Figure 2.67. This 'Blondin' ropeway at Pen yr Orsedd shows the traveller carriage drawn up to the mast. The travellers could be moved to any point on the catenary system over the pit, and a lifting rope lowered and raised.

Element 3.9 The Nantlle Railway

A long-lived narrow-gauge railway, which served the Nantlle Valley slate quarries from 1828 to 1963, and which reflects the transfer of technology devised by the Stephenson family to the Gwynedd region.

The Nantlle Railway, opened in 1828, was realigned several times as quarry pits were extended. It was built with Liverpool capital and engineered by Robert Stephenson the elder at a time when his brother George and nephew Robert had completed the Stockton & Darlington Railway and were designing the Liverpool & Manchester Railway, the two systems that defined the technology of the coming network of main-line railways worldwide. The Stephensons' innovative system of wrought-iron rails on stone block sleepers was used on the Nantlle Railway and was later adopted by the Ffestiniog Railway (Element 5.9). With the coming of the national rail network to the region in the 1860s and 1870s, it was reduced to this short section at its upper end. This was horse-worked almost until it closed in 1963.

Figure 2.69. The course of the Nantlle Railway, making its way to Pen yr Orsedd Quarry.

Figure 2.68. The Nantlle Railway was re-aligned over the years as the quarry pits were extended. This is a section of the original route of 1828. The flying arches were added later to prevent the slate tips of Dorothea quarry from encroaching on the track bed.

Element 3.10 Nantlle Village

The small village of Nantlle is a linear settlement associated with Pen yr Orsedd Slate Quarry, built along the historic turnpike road through the valley, part of which now forms the B4418 secondary route. It is dominated by the quarry tips immediately to its north. A pre-industrial settlement is centred on the sixteenth-century Ty Mawr [the great house] and a corn mill.

The village of Nantlle was developed from the 1860s to the 1890s by the socially conscious but controlling manager of Pen yr Orsedd Slate Quarry. It is an example within the Nominated Property of a planned settlement created not by an aristocratic landowner but by an industrialist whose Christian Unitarian beliefs supported his philanthropic outlook. It reflects the sudden demand for labour during the boom of the 1860s and the need to provide for newly-arrived families and young unmarried quarrymen leaving the rural hinterland.

Older and plainer houses predominate to the west, while a 'company village' employing a Picturesque architectural vocabulary is located in the centre, and more substantial late-nineteenth century housing is located to the east. Other structures include a barracks complex, sensitively conserved as a community and business centre, the Neo-Romanesque vestry of Baladeulyn Methodist chapel with its remarkable quarrymen's war memorial, and a larger house built for the Pen yr Orsedd quarry manager, now a residential centre.

Figure 2.71. Some attempt at decoration is evident in these houses in Nantlle village.

Figure 2.70. The village of Nantlle grew up piece-meal from the 1850s, and housed the Pen yr Orsedd workforce and their families.

Element 3.11 Settlements on Cilgwyn Mountain

These squatters' cottages and irregular field-plots cover the mountain common to the north, leaving only the summit uncultivated. Some are inhabited, others are in ruin. They are bisected by the western Cilgwyn Slate Quarry Tip.

Workers' settlements within the Component Part include scattered cottages and field systems on the mountain common at Cilgwyn, enclosed without any legal authority on land belonging to the Crown by people attracted to the industry in the first three decades of the nineteenth century. Cottage names such as 'Samaria' (the Biblical name for the land despised by the Chosen) and 'Greenland' (a very cold place) indicate their marginal nature.

Figure 2.73. Some of the Cilgwyn cottages are still inhabited. They show how the slate-quarrying population of Nantlle evolved their own way of life, sometimes in defiance of authority.

Figure 2.72. Quarryman-cottager settlements were established on the southern (right-hand) slopes of Cilgwyn mountain in the first decades of the nineteenth century and were mostly abandoned by the 1930s.

Barns, farmhouses and field systems adjacent to the course of the Nantlle Railway, and at the foot of tips of slate waste, illustrate the transition from an agricultural economy to an industrial society, which nevertheless retained many of its earlier characteristics.

The earliest structures are vernacular farmhouses of seventeenth and eighteenth-century date, and a later *plas* [high-status house] for a minor landowner which shows some attempt at Georgian order, which subsequently became the home of a socially ambitious quarry manager. As the quarries expanded, a stable, a terraced row and a small ironworks, 'Foundry Terrace', were added.

Figure 2.74. Tal y Sarn Uchaf cottages were built adjacent to an earlier farmhouse in the 1860s to house men working in the nearby Dorothea Quarry, and for men and women operating slate trains on the Nantlle Railway.

Figure 2.75. Amongst the buildings adjacent to Tal y Sarn farmhouse is this stable built in the 1860s for horses pulling wagons of Dorothea slates along the Nantlle railway.

Summary of values and attributes

The Nantlle valley belonged to many different landowners, and for this reason developed as many separate quarries. Much of the older, rural landscape remains evident because of the need to preserve boundaries between estates. Uniquely within *The Slate Landscape of Northwest Wales*, geology and topography meant that slate deposits could only be opened out as pits; as a result, ingenious methods were employed to raise blocks and rubble, as well as to pump water out of the deep and confined workings. Systems adapted from other industries are evident, in the form of catenary 'Blondin' ropeways spanning the pits (named after Charles Blondin who crossed the Niagara gorge on a tightrope in 1859), initially developed in the freestone quarries of Scotland, and water-driven and steam pumping systems from Cornwall. A long-standing tradition of local ingenuity is also apparent in this Component Part's own artisan technologies such as 'chain incline' ropeways, which ran from the pit-bottoms to massive slate bastions.

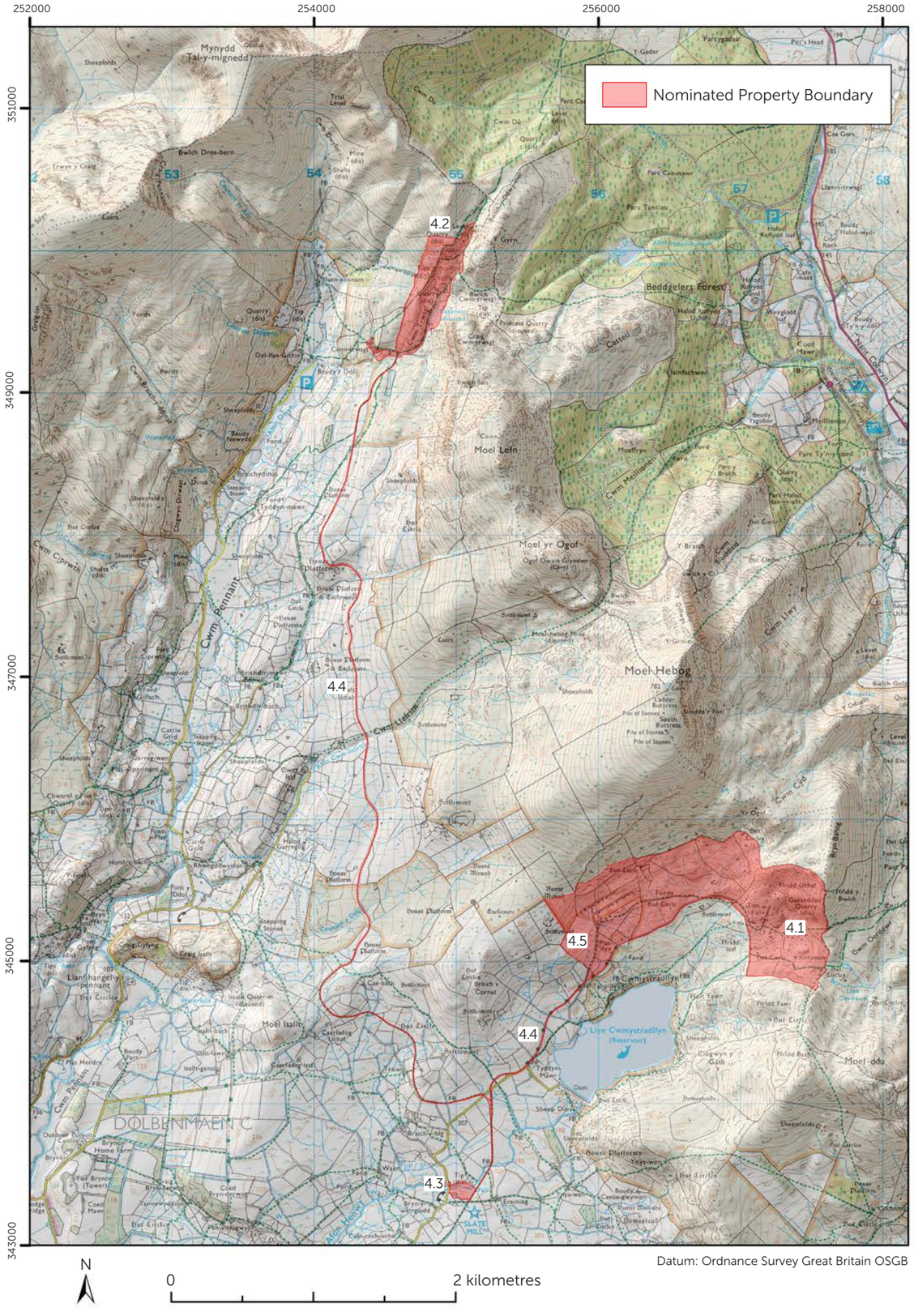
Settlement takes a variety of forms. Pre-industrial farmhouses survive within the quarries, embodying the transition from a traditional agricultural economy to an industrial society. Squatters' cottages and field-plots cover the mountain common to the north, leaving only the summit uncultivated. The village of Nantlle is a model settlement created by a socially conscious but controlling quarry manager. Barrack buildings for newly arrived families and young unmarried quarrymen leaving the rural hinterland illustrate the sudden social and economic changes in the fabric of regional society, and explain the survival of many pre-industrial practices and attitudes. The many tiny shelters built on the tips in the 1930s by impoverished quarrymen to re-work slate exemplify both the contraction of the industry and the determination of its people to wrest a living from it in difficult circumstances.

External capital and skill is evident in the course of the Nantlle Railway of 1828, the first public railway in the slate industry, built with Liverpool finance and with the advice of the Stephenson family, using the wrought-iron rail technology they had recently used to good effect on the Stockton & Darlington Railway and were currently applying to the Liverpool & Manchester Railway.

COMPONENT PART 4

Gorseddau and Prince of Wales Slate Quarries, Railways and Mill

Figure 2.76. Both quarries are visible in this aerial view, Gorseddau overlooking the lake and Prince of Wales just below the mountain ridge at the top left of the photograph.



Map 2.5. The boundary and Elements of Component Part 4: Gorseddau and Prince of Wales Slate Quarries, Railways and Mill (Scale 1:35,000).

Location and setting

Prince of Wales Slate Quarry is located 5km east-south-east of Nantlle village (Component Part 3), across the Nantlle Ridge and its central peak of Mynydd Tal y Mignedd (653m). Both quarries (Gorseddau is 5km south-south-east of Prince of Wales), are located within the same Ordovician slate-bearing area that runs for around 6km, trending roughly from northwest to southeast. Cwmstradllyn and Cwm Pennant form two little-visited and barely populated valleys which unite downstream. In each case, a vein of slate was quarried, with little commercial success, on high ground at the valley-head. Hills rise to between 550 and 650m above the valleys. The landscape is dominated by farmland in the valleys and open grazing on the ridges. The 700-hectare Beddgelert Forest is located 0.5km east of Prince of Wales Slate Quarry. Both quarries are connected by the extant courses of railways to the Ynysypandy slate-slab mill. The longer railway from Prince of Wales Slate Quarry winds its way southwards down the eastern hillside contour of the Pennant Valley for some 8km before joining the shorter (2.5km) Gorseddau Quarry Railway in the final shared 0.75km stretch to Ynysypandy.

Summary

This short-lived quarrying area is notable for the survival of features often lost at more commercially successful operations. It includes the isolated Gorseddau Slate Quarry, abandoned soon after it began operating in the mid nineteenth century, its railway, a deserted worker settlement at Treforys, the dramatic Ynysypandy slate-slab mill preserved by the Snowdonia National Park, and the Prince of Wales Slate Quarry.

Elements

The five Elements of this Component Part date from the 1850s to the 1880s, within a remote upland landscape.

Table 2.5 Component Part 4 Elements

Element 4.1	Gorseddau Slate Quarry
Element 4.2	Prince of Wales Slate Quarry
Element 4.3	Ynysypandy Slate-Slab Mill
Element 4.4	Gorseddau Railway and Gorseddau Junction & Portmadoc Railways
Element 4.5	Treforys Village

Element 4.1 Gorseddau Slate Quarry

A relict slate quarry which made use of the system of stepped galleries pioneered at Penrhyn Slate Quarry and a narrow-gauge railway that once provided a connection to the wharves at Porthmadog.

The Gorseddau Slate Quarry reflects the growing demand for slate in the expanding economy of the 1850s, and forms a distinctive gash in the hillside of Cwm Ystradllyn. Because of the poor quality of rock, the quarry failed here after only a few years, leaving evidence of working practice that has often been obliterated elsewhere. In its short working life it was opened up on the system introduced at Penrhyn Slate Quarry (Element 1.1) sixty years earlier as eight stepped galleries feeding an inclined plane, its tips of waste rock extending on either side. Other surviving assets include blast-shelters and slate-splitters' shelters, as well as a barracks, office and smithy, setting out mid-nineteenth century slate-quarrying practice, and exemplifying the sudden arrival of capital in this remote location.

Figure 2.78. This masonry retaining wall protects the Gorseddau Railway from the large tip of waste rock.

Figure 2.77. Gorseddau Slate Quarry from the southwest.

Figure 2.79. Prince of Wales Slate Quarry was opened on the same system of stepped galleries as Penrhyn, Dinorwig and Gorseddau. This view shows the higher incline, the tips, the working floors, slate-makers' shelters and the barracks.

Element 4.2 Prince of Wales Slate Quarry

A relict slate quarry, worked from the 1860s to 1881, which made use of stepped galleries. It illustrates working practices from the industry's height, and technologies imported by managers from Penrhyn Slate Quarry and its Felin Fawr slate-slab mill.

The Prince of Wales Slate Quarry reflects the building boom of the period from the 1860s to 1877. It was mainly worked in stepped galleries, of which there are seven, though there is also evidence of shafts being sunk on working floors and opened out laterally in an attempt to access the slate underground. Buildings include slate-splitters' shelters, blast-shelters, a stable, weighbridge houses, an office and barracks, essential in such a remote location. The two counterbalanced inclined planes form impressive features; these transported finished slates as well as raw blocks to the Quarry's own slate-slab mill.

The dam which powered this mill is a substantial feature, consisting of two large walls constructed from dressed rubble blocks. Downstream, the water-supply to the mill waterwheel pit is evident as a row of pillars which once supported a wooden trough.

The form and organisation of the mill itself anticipates that of the slightly later Felin Fawr slate-slab mill (Element 1.2), with transverse access through three arched doorways. From here, the course of the railway, which carried away the finished product, is evident.

Figure 2.80. The mill serving Prince of Wales Slate Quarry was designed by John Francis, the manager of Penrhyn Slate Quarry, and his son, when they were also begining to remodel the Felin Fawr slate-slab mill in Component Part 1. It was built in 1864. The waterwheel that powered it was located against the standing left-hand gable. In the distance, the formation of the railway makes its way down the valley. The mill illustrates the technology of transfer within the slate industry of Wales.

Element 4.3 Ynysypandy Slate-Slab Mill

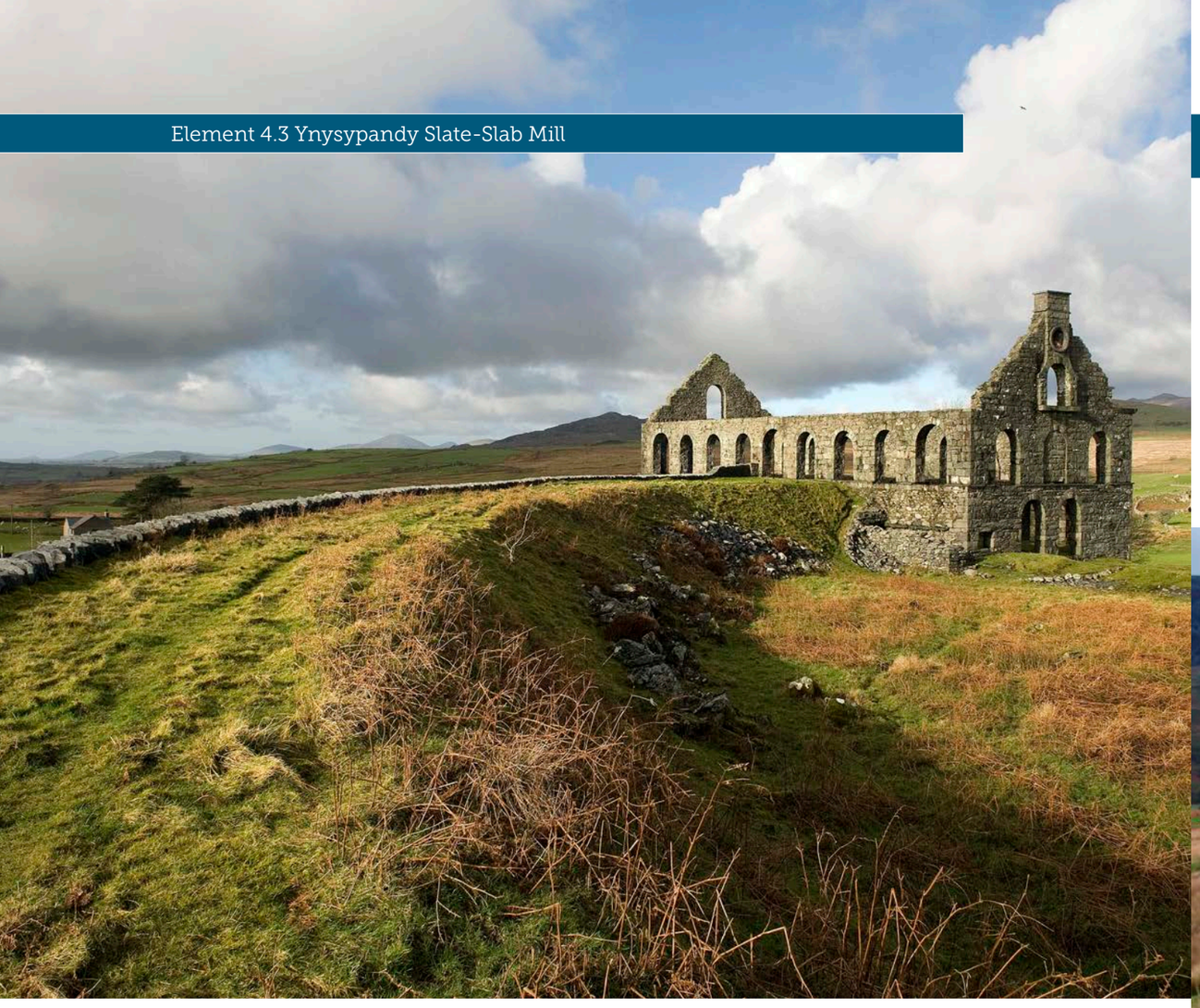


Figure 2.81. Ynysypandy slate-slab mill was powered by a water-wheel fed from the nearby stream. The heavier machinery was installed on the ground floor and lighter work was carried out on the higher levels. Raw blocks and finished products were transported in and out by the railway sidings on the formation in the foreground.

Ynysypandy is a disused and roofless water-powered mill, which processed slate slabs; a striking and architecturally ambitious structure, now conserved.

The unique multi-floor slate-slab mill that served Gorseddau Slate Quarry from 1857 to 1866 is architecturally ambitious and imposing in its rural setting. Its foundry design reflects the background of Gorseddau's shareholders and engineers in the growing national railway network.

Element 4.4 Gorseddau Railway and Gorseddau Junction & Portmadoc Railways

The soundly-constructed Gorseddau Railway was built in 1854-7 for horse and gravity operation. The Gorseddau Junction & Portmadoc Railways was a lightly-built line to the Prince of Wales Quarry intended for locomotive haulage.

The railway systems that served the two quarries exemplify different approaches to construction. The well-engineered line completed in 1857 to Gorseddau Slate Quarry was built by James Brunlees (1816–1892) and his colleague Daniel Makinson Fox (1830-1918), both of whom had distinguished international careers as railway-builders. By contrast, the Gorseddau Junction & Portmadoc Railways of 1875 to Prince of Wales Slate Quarry was constructed by a local contractor, Richard James Davids of Caernarfon, to a much poorer standard, despite its pretentious title.

Figure 2.82. Despite its grandiloquent title, The Gorseddau Junction & Portmadoc Railways consisted of a single line of track, built as inexpensively as possible to carry light traffic, typical of many industrial systems across the world. Well over a hundred years after it was scrapped, the impressions of wooden sleepers are still apparent.

Element 4.5 Treforys Village

An abandoned designed upland workers' settlement built in the 1850s to serve Gorseddau Slate Quarry.

The planned village of Treforys is a deserted and ruinous settlement located on a hillside 1km west of the quarry. It consists of 18 pairs of rubble-built semi-detached two-room cottages on three parallel streets with straight flanking walls, similar to, and possibly inspired by, Scottish and Irish planned estate villages as well as by Mynydd Llandygai (Element 1.5).

Figure 2.83. Whoever drew up the plans for the village of Treforys failed to appreciate how uneven, boggy and infertile the slopes were. The manager's house was located in the trees to the right. Its name means 'Morris's Town', after Richard Morris Griffith, a local banker who helped find the capital, but to local people it was 'Johannesburg' – a synonym for a new and lawless industrial community.

Summary of Values and Attributes

The Gorseddau Slate Quarry and the Prince of Wales Slate Quarry form a relict landscape that illustrates both the commercial optimism of the boom years of the slate industry of Wales from the 1850s to the 1870s, and the working methods of the period. Both quarries follow the Penrhyn style of stepped galleries in the hillside. Both are served by water-powered slate-slab mills. Ynysypandy mill, which served Gorseddau Slate Quarry, is an adaptation of a foundry design, reflecting the investors' background in railway operation. The mill at Prince of Wales Slate Quarry shows the transfer of techniques evolved at Penrhyn Quarry. The two railways illustrate different approaches to building an industrial transport link – the Gorseddau was soundly built for traffic that barely materialised; the Gorseddau Junction & Portmadoc Railways was an attempt to embody the Ffestiniog Railway's approach but cheaply constructed and very lightly laid.

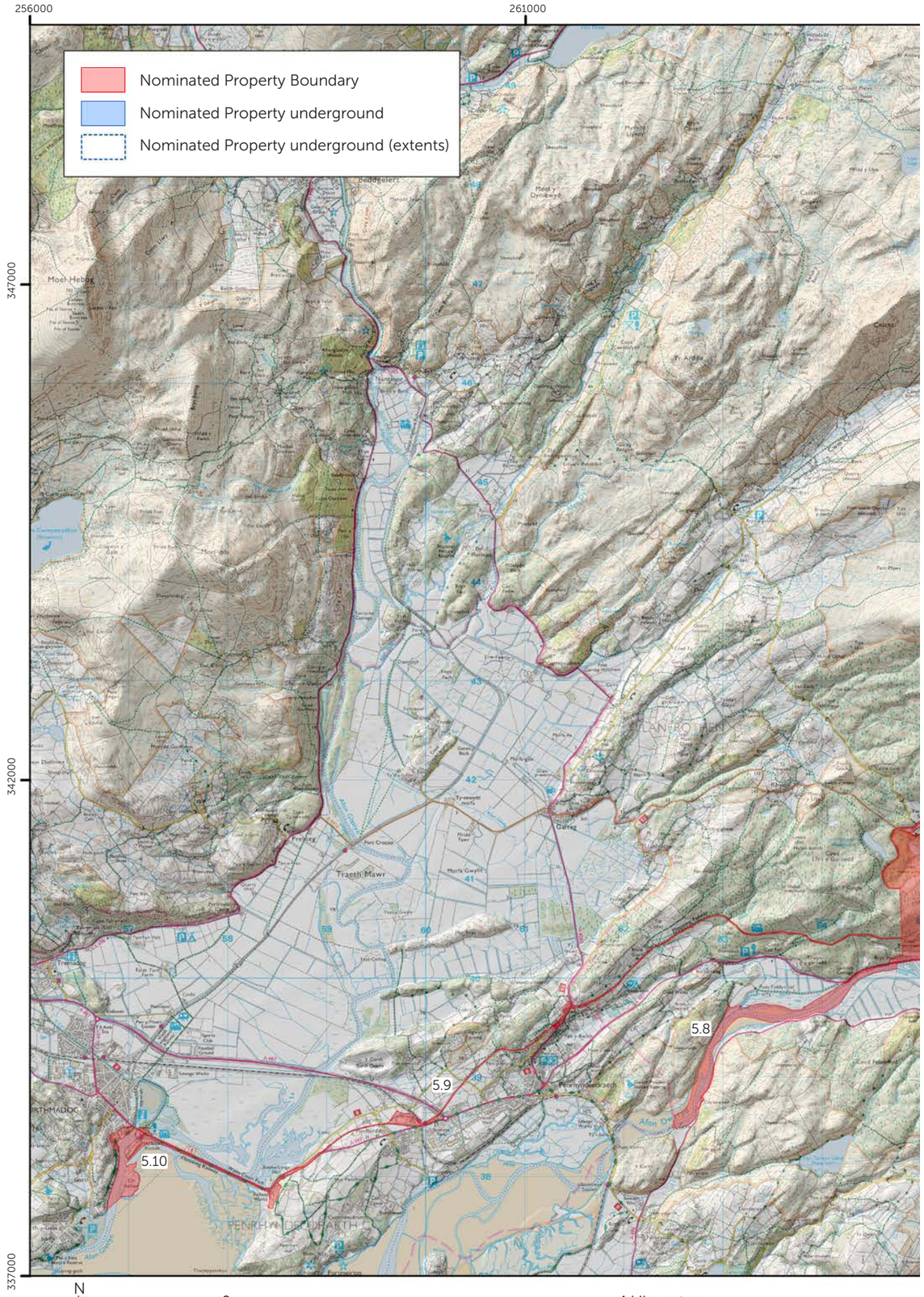
The remains of barracks are evident at both quarries, though the most remarkable settlement within this Component Part is the village of Treforys, under construction in 1857. The design reflects current ideas about re-housing rural populations familiar to Gorseddau's board of directors and to its engineer, James Brunlees, who also designed the railway to Porthmadog.

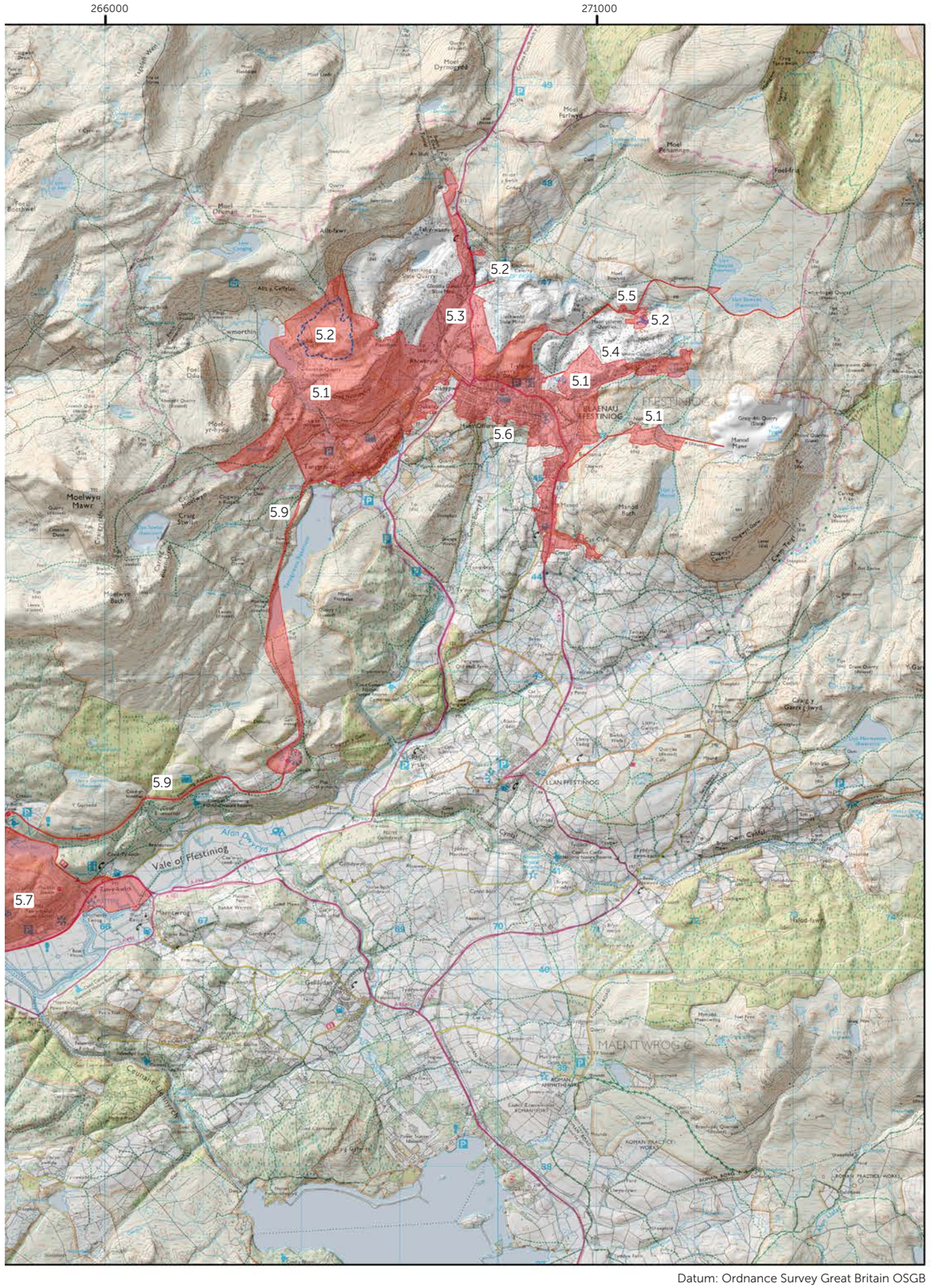
Figure 2.84. The challenges of living in the company village of Treforys are evident in this view of the middle street, showing three of its eighteen semi-detached cottage structures. It was visited by smallpox in the winter of 1859-60 and abandoned when Gorseddau Quarry closed a few years later.

COMPONENT PART 5

Ffestiniog: its Slate Mines and Quarries, 'city of slates' and Railway to Porthmadog

Figure 2.85. The whole of the Ffestiniog landscape can be seen in this aerial view, from the quarry surface landform and the town of Blaenau Ffestiniog to the line of the Ffestiniog Railway to Porthmadog.





Datum: Ordnance Survey Great Britain OSGB

Map 2.6. The boundaries and Elements of Component Part 5: Ffestiniog: its Slate Mines and Quarries, 'city of slates' and Railway to Porthmadog (Scale 1:50,000).

Location and setting

Ffestiniog is an upland area on the southern limits of the Snowdon massif, between the Manod (661m) and Moelwyn mountains (770m); their peaks are collectively known as the Moelwynion range. The quarries and town are located around 16km southeast of Dinorwig (Component Part 2) and 12km east of the Gorseddau and Prince of Wales quarries (Component Part 4). Ffestiniog is situated in the second major slate belt (Meirionnydd Slate District, Ordovician) where the slate formations dip under the mountains. High-quality slate was mined extensively from underground.

Testimony to the huge output of systematic underground exploitation is a vast network of cavernous chambers, divided by pillars or walls that supported the roof, and which connected horizontally via a series of levels or floors, and vertically by underground inclined planes. Some of the mines were characteristically 'un-topped', whereby unproductive surface rock was removed to recover high-quality slate remaining in pillars, being subsequently turned into surface quarries. Together with voluminous tips of waste rock, their landform scale dominates the hillsides above the town.

'Blaenau Festiniog [sic] might well be termed the "city of slates"'
(anonymous journalist, 1873).

Once the inclined veins of grey Ordovician slate came to be quarried and mined here, a natural shelf on the lower slopes became the focus for settlements which evolved into the 'city of slates' – Blaenau Ffestiniog, the most distinctively urban of the slate quarry settlements. Today the town has a predominantly Welsh-speaking population of almost 5,000, but was home to nearly 12,000 people during the peak years of the industry. The town receives the highest rainfall of any town in Wales, and the area is drained by the Dwyryd River. This provided a natural gateway to the sea and to the harbour at Porthmadog, located in a northerly inlet of the wide sandy Glaslyn estuary around 15km southwest of Ffestiniog. The river itself was the initial export route for the large output of slate from great mines and quarries under different ownership, but from 1836 it was the Ffestiniog Railway that connected the quarries with ocean-going ships, following a spectacular sinuous contour formation along the valley slopes. Geographical setting has shaped the characteristics and technical achievements of the railway, determining its path and influencing its development over time.

Summary

This Component Part includes a representative group of underground mines, quarries, associated tips and mills and the largest slate town in Northwest Wales, Blaenau Ffestiniog, with its formal urban organisation; also Plas Tan y Bwlch, formerly the home of a major quarry-owning family and now the Snowdonia National Park residential study centre, quays on the Dwyryd river, the innovative slate-carrying Ffestiniog Railway, still operational, and Porthmadog Harbour.

Elements

Elements of this Component Part date from the 1820s to the 1930s.

Table 2.6 Component Part 5 Elements	
Element 5.1	Ffestiniog Slate Quarries – Surface Landform
Element 5.2	Ffestiniog Slate Quarries – Underground Workings
Element 5.3	Pant yr Afon Hydro-Power Station
Element 5.4	Diffwys Slate Quarry Mill
Element 5.5	Maenofferen Slate Quarry Main Complex
Element 5.6	Blaenau Ffestiniog Town
Element 5.7	Plas Tan y Bwlch
Element 5.8	Slate-quays on the Dwyryd River
Element 5.9	Ffestiniog Railway
Element 5.10	Porthmadog Harbour

Element 5.1 Ffestiniog Slate Quarries – Surface Landform

Figure 2.86. This view of the quarries brings out the scale of surface operations in the Ffestiniog slate landscape, but these were only a small part of the whole compared to the underground workings beneath them. The tips of waste rock dominate the town.

The vast landform of the Ffestiniog quarries was created from the late eighteenth century onwards. It includes early surface quarries which, as demand grew, had to be extended underground by following the inclined veins of Ordovician slate, as well as open workings which were created by removing top-rock in later times.

The surface landform of the Ffestiniog slate quarries is striking. Different vantage points offer views of the enormous tips of waste slate rubble that dominate the town, or of the huge open workings. There are five principal slate workings, from west to east: Cwmorthin, Oakeley, Llechwedd, Maenofferen and Diffwys.

Other features include mill buildings where slate was sawn and split.

Figure 2.87. Amidst landform tips of waste slate, the straight linear landscape feature of an inclined plane contrasts with a zig-zag pedestrian path for quarrymen that leads to Oakeley Quarry.

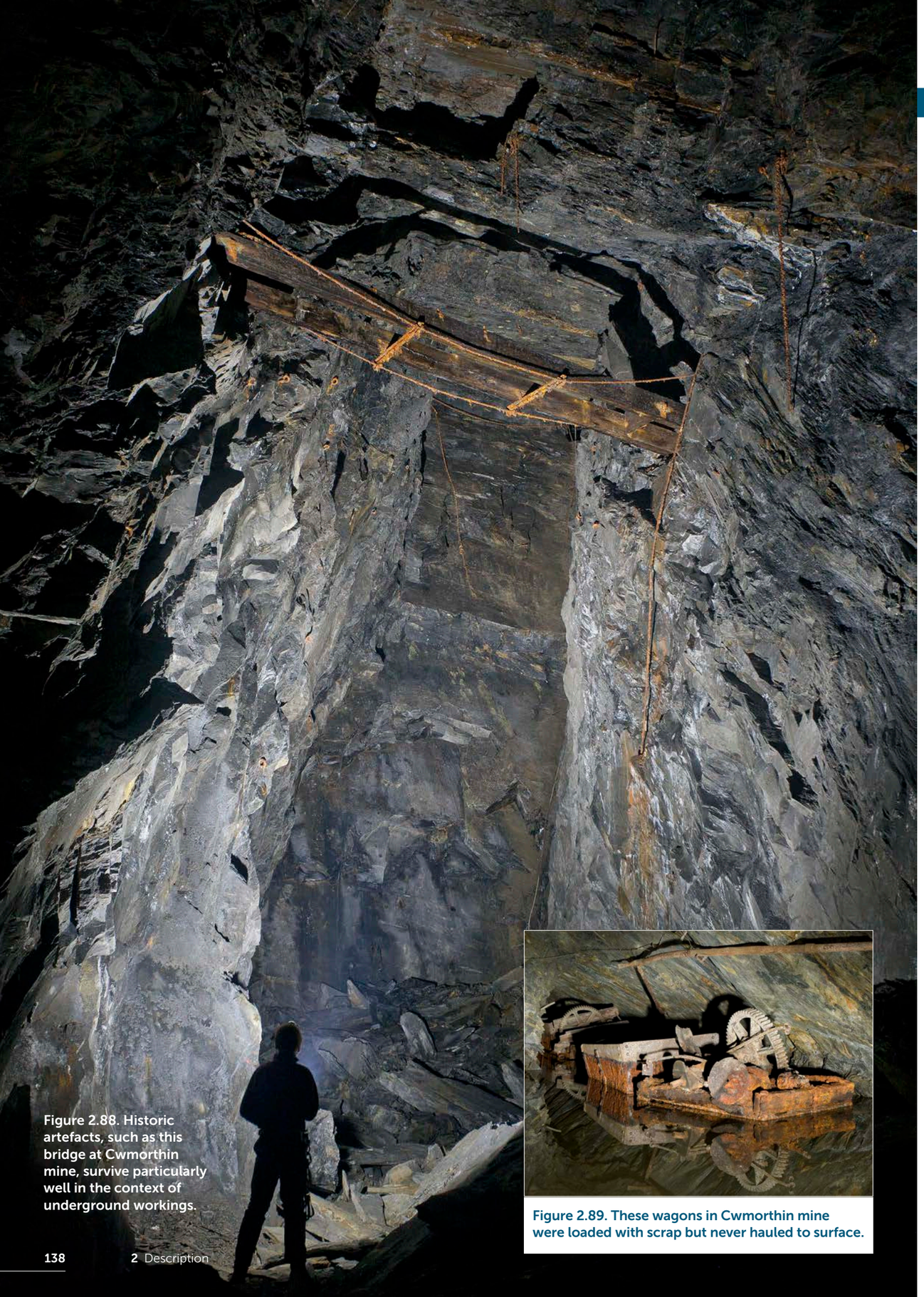


Figure 2.88. Historic artefacts, such as this bridge at Cwmorthin mine, survive particularly well in the context of underground workings.

Figure 2.89. These wagons in Cwmorthin mine were loaded with scrap but never hauled to surface.

The inclined veins of Ordovician slate dictated the form of the chambers which make up the underground workings at Ffestiniog, and the tunnels which gave access to them.

A technical selection of the extensive underground workings has been undertaken to ensure that all those which make the most substantial contribution to the proposed Outstanding Universal Value of the Nominated Property have been included. These are at Cwmorthin Slate Quarry and parts of Maenofferen Slate Quarry, and include spectacular honeycomb chambers under the mountains where in many cases, machinery, complete inclined planes and railway system survive intact; the underground workings also preserve smaller and more ephemeral artefacts such as boots, newspapers and cigarette packets.

Ffestiniog slate mines evolved around an inclined plane dropping from a processing and tipping floor into an open *sinc* (literally, a 'sinking'), then disappearing from sight through a cavernous opening in the rock face immediately under the 'hard' (chert deposits above the slate), following the dip of the vein. Once the miners had driven the shaft for the incline, they drove lateral tunnels known as 'levels' following the orientation of the vein at vertical intervals of about 12m to give access to chambers where the rock was worked; further inclines underground as necessary gave access to deeper levels still. Some underground workings were accessed by a level tunnel from the open, of which examples are evident at Cwmorthin and Maenofferen.

Figure 2.90. Inclined planes frequently survive intact in the underground workings of Ffestiniog. This is the back vein inclined plane at Cwmorthin.

Element 5.3 Pant yr Afon Hydro-Power Station

The Pant yr Afon hydro-power station is a rare example of an early twentieth-century hydro-electric power station, with most of its original machinery, a complete example of the industrial use of water-power.

The Pant yr Afon hydro-power station of 1904 is a surviving and functioning example of an early industrial electricity generating station with water-powered turbines. This innovative way of exploiting the heavy rainfall of the area was exploited to operate and inclines in Llechwedd quarry. It is located at the wharf where Llechwedd Quarry's slate was transferred to the national railway network, and now supplies the national grid. The two preserved Gilkes pelton-wheels each drove a Johnson & Phillips 175 kilowatt generator.

Figure 2.92. The Pant yr Afon hydro-power station was established in 1904, and is one of the oldest operational water-driven electricity-generating stations known anywhere. The slate industry of Wales was cautious about investing in electrical plant but made considerable use of it once it had proved itself, especially when the price of coal increased.

Figure 2.91. The original machinery is retained in the listed Pant yr Afon hydro-power station alongside a new hydro set.

Element 5.4 Diffwys Slate Quarry Mill

This steam-powered mill in Diffwys quarry was built in several stages and is one of the earliest 'integrated' mills, where all the processes for producing roofing slate are carried out in one place.

The prominent steam-powered mill at Diffwys Slate Quarry was the first major processing site in the Welsh slate industry where powered machinery was used to carry out the initial reduction of blocks to produce roofing slates, rather than architectural slabs. Its earliest phase dates from the late 1850s or early 1860s, and it was subsequently extended to the west and east. The ruins crown the skyline.

Figure 2.93. The steam mill at Diffwys Slate Quarry has been out of use since the 1920s but survives to show how the process of converting raw blocks of slate from the mine into roofing elements took place.

Element 5.5 Maenofferen Slate Quarry Main Complex

A group of buildings and structures constructed from the 1860s onwards, which show the typical surface technology of slate working in the Ffestiniog Component Part.

This exceptionally well-preserved quarry complex has features typical of the Ffestiniog Component Part, including a late nineteenth century slate mill, operational until the 1990s, with evidence for water, steam and electrical power, ancillary buildings and an up-haulage inclined plane from the extensive underground workings.

Figure 2.94. Maenofferen Mill is the best and most complete surviving example of a late nineteenth century slate processing site.

Figure 2.95. The up-haulage inclined plane at Maenofferen was initially powered by steam and later by electricity. It worked until the 1990s.

Element 5.6 Blaenau Ffestiniog Town

Figure 2.97. The construction of large and architecturally flamboyant chapels began in the 1860s – coincident with a boom in the slate industry. Examples include Rhiw Calvinistic Methodist Chapel, Rhiwbryfdir (1867-68) with the 'halo arch' front characteristic of many Welsh chapels.

The town of Blaenau Ffestiniog evolved from the 1820s to 1900 to house a new and expanding workforce, its shops, public houses, places of worship and reading rooms reflecting a new way of life.

Blaenau Ffestiniog is a remarkably well-defined industrial town founded by slate quarrymen and their families where before 1820 there had been only been fields and farmhouses. Rapid growth of this 'city of slates' was entirely sustained by the exploitation of slate, its character moulded in just a few decades. It is connected to the industrial landscape of mines, quarries and railways by a network of tracks and roads.

Figure 2.98. The Square and park at Blaenau Ffestiniog show how this raw industrial settlement evolved to house its growing middle class.

Blaenau Ffestiniog is located on a natural shelf below the *blaenau* ['uplands'] of the parish of Ffestiniog. It is the most distinctively urban and planned of the slate quarry settlements. It is also the largest, with its series of communities linked in a long linear settlement. In total, over 4km of urban ribbon is included, strung out along the A470 road (a route built piecemeal, but essentially completed by 1830, and now the main north-south Welsh road) in a horseshoe-shape centred on the head of the Bowydd Valley, extending from the western end of the town in a southerly direction to Tan y Grisiau, and from the eastern end of the town in a southerly direction through Bethania and Manod to Congl y Wal (see Figure 2.1). The roads provided an urban development framework, as did the Ffestiniog Railway, especially at Tan y Grisiau. Early houses were built along these transport axes. Topography exerted a constant constraint.

Formally planned squares and substantial dwellings were laid out for the town's service middle-class, as well as quarrymen's terraces. There are four Anglican churches in the town, and some forty chapels, providing an indication of the scale and range of the faith of the community.

Figure 2.96. The town of Blaenau Ffestiniog lies at the foot of the slate mines and quarries which brought it into being.

Element 5.7 Plas Tan y Bwlch

Plas Tan y Bwlch is a country house, now the Snowdonia National Park study centre, which illustrates the wealth generated by the slate industry.

Plas Tan y Bwlch is the former home of the Oakeley family, whose landed estate included three of the major Ffestiniog quarries, and is now the Snowdonia National Park residential study centre. Standing on the site of a much earlier dwelling, the house has an eighteenth-century frontage but mainly dates from 1868-86, when it was rebuilt and expanded and the extensive terraced gardens laid out. It overlooks the Dwyryd river, where slate was transferred from carts to boats. The Ffestiniog Railway (Element 5.9) passes through its grounds.

Figure 2.99. Plas Tan y Bwlch was enlarged and altered in the second half of the nineteenth century on the profits of the Oakeley family's quarries in Ffestiniog.

Element 5.8 Slate-quays on the Dwyryd River

Ffestiniog slates were initially taken by cart to quays on the Dwyryd river, then boated to Porthmadog.

The earliest export of slate in this Component Part relied heavily on river traffic and this continued even after the introduction of the railway. Cart-roads laid out in the eighteenth and nineteenth centuries carried slate to purpose-built quays where it was transfered to small boats. Two of the river-quays built by the quarry companies are particularly well-preserved and are included in the Nominated Property.

Figure 2.100. Tyddyn Isa is one of the best-preserved of the quays where slate was transferred from road carts to river-boats crewed by boatmen known locally as 'Philistines' (for reasons unknown) before being loaded into sea-going ships. Tyddyn Isa served early slate workings near the present Maenofferen Quarry, and was built by Jack Griffith, a contractor from the nearby town of Dolgellau, in 1823-4.

Element 5.9 Ffestiniog Railway

This innovative and highly influential 0.6 metre gauge railway system carried slate from Ffestiniog to Porthmadog harbour from 1836 to 1946, and now operates as a visitor attraction with its historic steam locomotives and fleet of carriages and wagons.

The Ffestiniog Railway is a pioneering narrow-gauge system built to connect the quarries with the sea by means of a sinuous course to Porthmadog Harbour, which is still operational for pleasure craft.

This system adopted and improved the technology of the existing slate-carrying railways of northwest Wales. It adopted the 0.6 metre gauge of the Penrhyn Slate Quarry Railroad (Element 1.3) and the Stephenson technology of stone blocks and wrought iron rails of the Nantlle (Element 3.9) when it was completed in 1836 as a horse- and gravity-operated mineral line. It later took this design tradition into the era of steam traction and passenger carriage when it was modernised in the 1860s. The Ffestiniog Railway was immensely influential across the world following the visits of officials and engineers to North Wales in 1870. It was the inspiration for the Darjeeling Himalayan Railway, one of the World Heritage Mountain Railways of India, as well as for the Talyllyn Railway (Element 6.4) and the Penrhyn Slate Quarry Railway (Element 1.3). Following a period of closure, the railway was re-opened in stages from 1955 to 1982. It preserves much of its original formation, buildings, locomotives and rolling stock, including its historic fleet of Victorian slate wagons. Within the Nominated Property, the inclined planes connecting the quarries with the Ffestiniog Railway form spectacular landscape features.

Figure 2.102. The Ffestiniog Railway has undergone transition from a horse-and-gravity operated slate railway to a small but intensively worked public railway, and is now a major tourist attraction.

Figure 2.101. A characteristic of the railway is its use of stone-faced causeways to carry it over tributary streams.

Located in the broad and sheltered Glaslyn estuary, which opens to the Irish Sea, this was the shipping point for Ffestiniog slate from the early nineteenth century, initially served by river-boats and from 1836 by the railway.

The quays, built between 1824 and 1867, remain in use for pleasure craft, and a surviving slate shed is now the Maritime Museum. Other features include timber warehouses, a seamen's mission and 'Ellis' island', the ballast bank made up of stone brought from all the harbours across the world from which ships came to Porthmadog to pick up slate cargoes. Between 1824 and 1914, most Ffestiniog slate was exported from here.

Figure 2.103. The last stage of the journey from the quarries to the sea takes the Ffestiniog Railway over a sea-defence built in 1808-1811, shown here on the right. Diverting the Glaslyn River scoured out a harbour (left). The quays were built between 1824 and 1867 to facilitate the transfer of Ffestiniog slates, initially from small river-boats, later from the railway, to ocean-going sailing ships. The Ballast Bank (left foreground) is made up of stones discarded as ballast from slate-ships returning without a cargo. Porthmadog Harbour is widely used by pleasure craft.

Summary of values and attributes

This slate-quarrying area developed from the mid-eighteenth century with the arrival of skilled quarrymen from Cilgwyn Slate Quarry in Nantlle but only took off with major investment from England and Ireland in the early nineteenth century. Because the slate could only be won from underground once the initial quarries developed, this became the foremost area of slate mining; the multi-level tunnels and the hundreds of chambers, many of which are very well preserved, contain a wealth of artefacts. The town which grew up to house the workforce is the most urban of the slate quarry settlements, and incorporated well-planned public spaces. The innovative Ffestiniog Railway to the harbour at Porthmadog was the inspiration for narrow-gauge systems all over the world.

It is an area where no one landowner completely predominated, and where different quarries came to be worked. Lord Palmerston, the British statesman, invested heavily in one of the Ffestiniog slate concerns; others were bankers from the Huguenot community of Dublin, and from Liverpool and the English West Midlands. They provided the capital for the underground workings from the 1820s, developing a distinctive 'honeycomb' approach which led to well over 100km of levels and chambers. Those at the Oakeley Slate Quarry and Votty & Bowydd Quarry have collapsed and those at Wrysgan are dangerous, but others survive in a good state of preservation, however; they are accessible and preserve a wealth of historic artefacts. Diffwys Slate Quarry had only limited underground working.

The building of the 0.6 metre gauge Ffestiniog Railway between 1832 and 1836 gave the quarries a more cost-effective outlet to the harbour at Porthmadog than the previous pack-horses, carts and river boats. It began as a horse-and-gravity mineral railway, drawing on existing technologies employed in the Penrhyn Slate Quarry Railroad and the Nantlle Railway, but was transformed between 1863 and 1872 into a small but fully fledged and high-capacity public railway. This proved a model emulated over the world, following visits from officials and engineers to Ffestiniog in 1870 at the invitation of its engineer, Charles Easton Spooner. The railway remains active as a popular visitor attraction, and preserves its authenticity as a nineteenth-century railway to a remarkable degree.

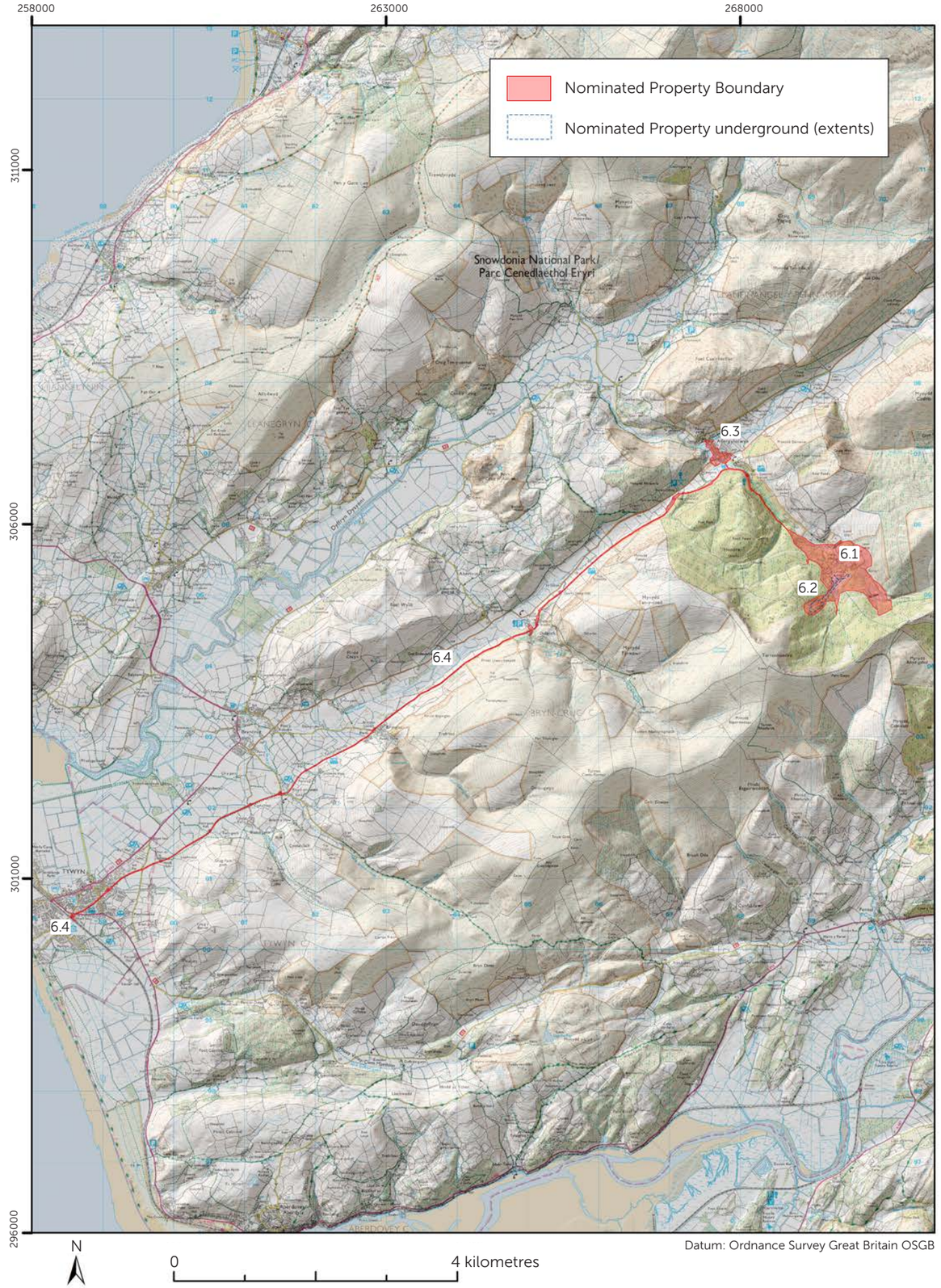
Blaenau Ffestiniog grew from a few scattered houses to a town of 11,274 by 1881. Its earlier unplanned ribbon developments are evident, and contrast with the confident architecture of the second half of the nineteenth century, with its impressive Nonconformist chapels and open public spaces.

The large-scale underground working of slate ceased in Wales in 1999 (at Maenofferen). Underground tours for both specialists and casual visitors interpret the industrial heritage of *The Slate Landscape of Northwest Wales*.

COMPONENT PART 6

Bryneglwys Slate Quarry, Abergynolwyn Village and the Talyllyn Railway

Figure 2.104. The village of Abergynolwyn is in the foreground, the Bryneglwys Quarry in the distance, and the railway follows the contours of the hill through the trees on the right.



Map 2.7. The boundaries and Elements of Component Part 6: Bryneglwys Slate Quarry, Abergynolwyn Village and the Talyllyn Railway with associated Elements (Scale 1:70,000).

Location and setting

Bryneglwys Slate Quarry is located within the fourth major slate belt to be included within the series. Ordovician slate outcrops are aligned with a small northeast-southwest-trending range of hills in southern Gwynedd, 38km south-south-east of Ffestiniog (Component Part 5). This Component Part consists of a slate quarry, the settlement that supported it, and the railway which connected them with the main line at Tywyn, a distinctive linear landscape feature that was the first slate quarry railway built for steam traction. This was also the world's first preserved railway, still operating for visitors. The area is rural, with open agricultural fields in the valley giving way to a patchwork of fields, open grazing and forest on the hills.

Bryneglwys Slate Quarry is situated in a shallow valley 2km southeast of Abergynolwyn village, to which it was connected by a slate railway that passes between the steep hills of Foel Fawr (350m, in the south) and Foel Pandy (454m, in the north). It then joins the Talyllyn Railway which follows the contour on the south side of the Fathew Valley for 12km west-southwest to Tywyn, 0.5km from the coast of the Irish Sea. 3.5km southwest of Abergynolwyn the railway passes Dolgoch Falls, a series of three waterfalls in a wooded ravine which flow into the Fathew River, where there is an adjacent station. At 6km from Abergynolwyn, the valley opens out into extensive farmland with nucleated settlements, offering views west to the open sea.

Summary

The quarry shows the influence of extractive techniques from Nantlle (Component Part 3) and from Ffestiniog (Component Part 5); this Component Part includes the Lancashire-pattern village, reflecting Manchester capital, and the first slate quarry railway built for steam traction and to connect with the national railway network rather than the sea – also a pioneering railway preservation project emulated worldwide.

As well as the surface features of the Bryneglwys Slate Quarry, underground workings remain accessible, within which wagons, rails and other artefacts survive. The quarry, the village and the railway all reflect investment and technology from the 1860s.

Elements

Elements of this Component Part date mainly from the 1860s.

Table 2.7 Component Part 6 Elements	
Element 6.1	Bryneglwys Slate Quarry Surface Landform and Chain Incline Ropeway Bastion
Element 6.2	Bryneglwys Slate Quarry – Underground Workings
Element 6.3	Abergynolwyn Village
Element 6.4	Talyllyn Railway

Figure 2.105. This aerial view looks southwest from the village of Abergynolwyn along the Fathew Valley to Tywyn. The line of the Talyllyn Railway can be traced at the top of the photograph through the line-side hedges at the base of the steep ground and left-hand edge of the valley pasture.

Element 6.1 Bryneglwys Slate Quarry – Surface Landform and Chain Incline Ropeway Bastion

An open quarry which worked two parallel veins of Ordovician slate from the 1840s, but which was only significantly developed during the boom of the 1860s, with capital from the Nantlle Component Part and from the Lancashire textile industry. The surviving stonework for its chain-incline ropeway of 1862-3 reflects a technology imported from the Nantlle slate quarries.

Bryneglwys Slate Quarry was opened in a narrow upland valley crossed by two veins of Ordovician slate. It made use of water-power, drawn from a reservoir on the Llaeron stream. The most prominent surviving feature is the bastion for a chain incline ropeway system site and the pits for the waterwheels which powered it. This device lifted blocks or slate and rubble from the open workings, and was based on a similar feature at Pen yr Orsedd Quarry (Element 3.7), long-since quarried away.

Figure 2.107. Bryneglwys Slate Quarry is the only remaining site where the technology of the water-driven chain incline ropeway for raising materials from open pits can be seen *in situ*. This distinctive system was brought to the area by Nantlle men in the early 1860s. A change of management shortly afterwards led to the start of a different method of working the rock – from underground chambers.

Figure 2.106. The surface landform of the Bryneglwys Slate Quarry, looking down the valley towards the village of Abergynolwyn. The two veins of slate ran across the valley.

Element 6.2 Bryneglwys Slate Quarry – Underground Workings

The steeply inclined Narrow Vein could only be worked from underground once it had reached a particular depth.

Several of the seven floors in the Narrow Vein workings are accessible and contain rails, wagons and winches. These floors connect with the open pit from which a chain incline system raised blocks and slate rubble.

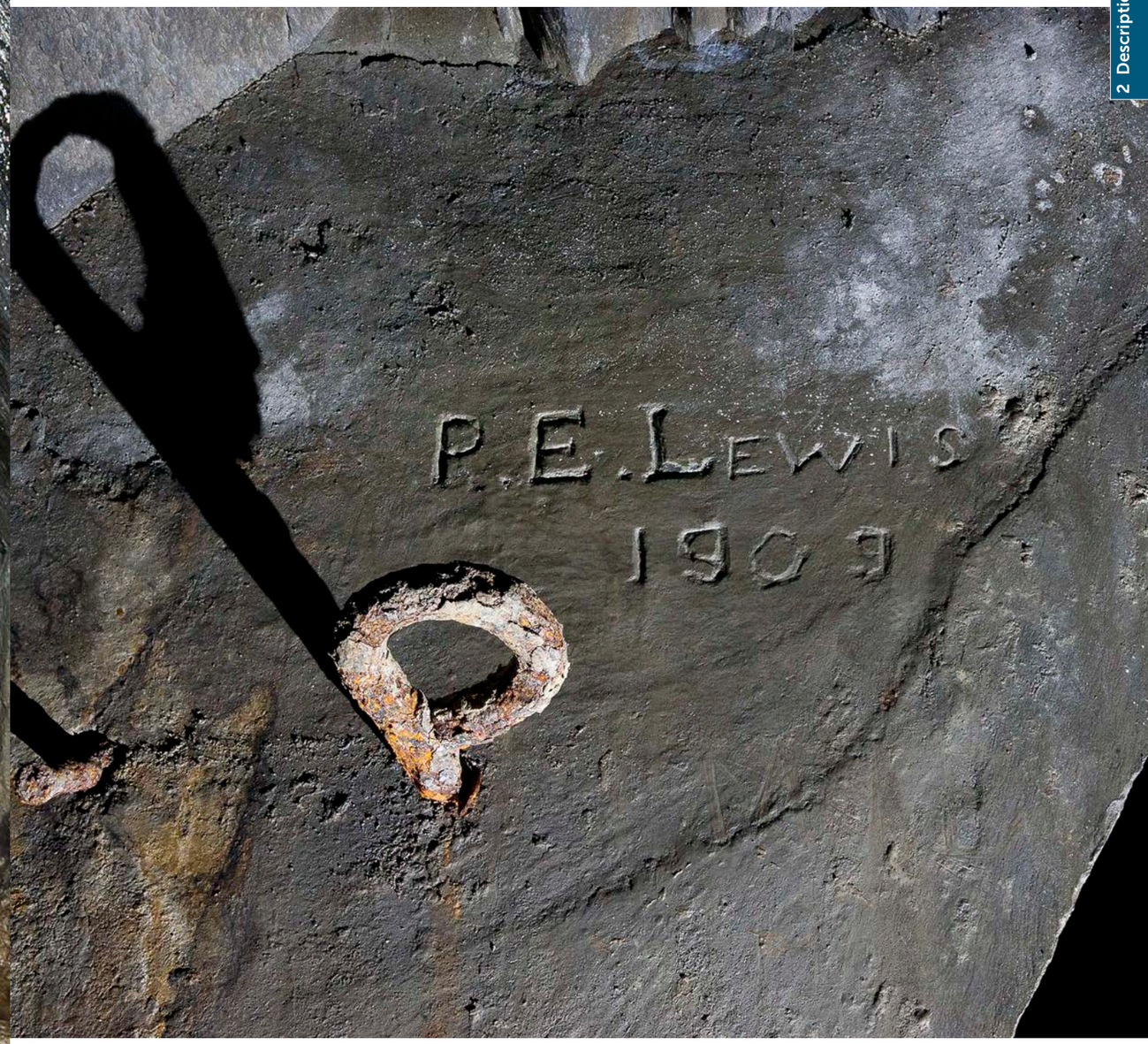


Figure 2.109. Graffiti recording the names and dates of quarry workers are often found underground in slate mines and quarries, and Bryneglwys is no exception.

Figure 2.108. Much of the underground workings at Bryneglwys is above the water table and accessible to specialists. They preserve equipment from various phases of the quarry's period of operation such as this flat wagon. See Figure 2.10.

Element 6.3 Abergynolwyn Village

Abergynolwyn village was built to house quarrymen and their families, and reflects the sudden influx of capital from Lancashire in the 1860s.

The village of Abergynolwyn was developed following the lease of Bryneglwys Slate Quarry by the Lancashire cotton-producers, the McConnel brothers, in 1864. Many of the houses are built to a design by a Manchester architect, James Stevens, in a North of England industrial idiom. Abergynolwyn also acquired chapels, a church, school and shops. A distinctive feature of the village is the trace of the inclined plane connecting it to the Talyllyn Railway, which delivered goods to the village and removed night-soil. It was probably the means by which the slate blocks of which the village is largely built were delivered.

Figure 2.111. Tan y Bryn Road in Abergynolwyn was laid out around 1870.

Figure 2.110. The settlement at Abergynolwyn was created around a pre-industrial farm on the turnpike road.

Element 6.4 Talyllyn Railway

An early narrow-gauge public railway, built for locomotive operation and passenger carriage from the outset, the first in Northwest Wales to connect a slate quarry with the national railway network rather than with the sea. Its construction reflects the boom in the slate industry in the 1860s, as well as experience gained on the recent modernisation of the Ffestiniog Railway. It was completed in 1866.

The Talyllyn Railway connected the Bryneglwys Slate Quarry with the national railway network near the town of Tywyn and was purpose-built for steam traction, reflecting experience gained on the Ffestiniog Railway (Element 5.9). It is also internationally significant as the first railway to be successfully operated by a preservation movement. Line-side hedges through pastureland on the lower section give way to shallow contour embankments and cuttings along wooded slopes as it climbs towards the quarry. It retains its original locomotives and carriages and some of its slate wagons, as well as of many of its nineteenth century buildings and infrastructure. The Narrow Gauge Railway Museum at Tywyn Wharf station interprets this technology, and sets out the role of the slate industry of Wales in its evolution.

Figure 2.113. *Dolgoch*, built in 1866, hauls a passenger train over the viaduct which is the main engineering feature of the Talyllyn Railway.

Figure 2.112. The Talyllyn Railway operates its original locomotives and carriages through a landscape which retains its nineteenth century character.

Summary of values and attributes

As an area developed during the boom period of the 1860s, Bryneglwys Slate Quarry, the village and the railway illustrate the sudden arrival of capital to the industry from the leading sector of Lancashire cotton. Its attributes show how both technology and assumptions about housing the workforce had evolved by the period when the industry was at its height. In addition, both the railway and the quarry illustrate how technologies developed elsewhere in the slate industry could be applied. Economic downturn has preserved key elements of this Component Part as they were when first developed.

The quarry lease was acquired by the Aberdovey Slate Co. Ltd (the McConnel brothers of Manchester, wealthy textile merchants) in 1864. The village took shape between 1865 and 1870. An unusual feature of this settlement is the inclined plane from the Talyllyn Railway, which connected the quarry with the standard gauge railway at Tywyn. This narrow-gauge system, 11.7 km long, was built for the McConnels by James Swinton Spooner, of the Spooner family associated with the Ffestiniog Railway. It was innovative in applying Ffestiniog principles such as locomotive haulage and a passenger service, and was the first slate carrying railway in North Wales to be built to connect a quarry with a national railway network rather than with the sea. It was also the first in the world to be rescued from closure by voluntary effort; since 1951 it has been operated by the Talyllyn Railway Preservation Society as a visitor attraction.

Figure 2.114. The Dolgoch Viaduct.

2.b History and Development

2.b.i Introduction

The Slate Landscape of Northwest Wales is a serial property located in the Snowdon massif of Gwynedd, Wales. It has evolved through quarrying and mining for slate, a building stone that lends itself to the production of finely grained roofing elements and other architectural products. It was exploited on a monumental scale – world-leading, and with a global reach – particularly between 1780 and 1940. Welsh Slate was frequently specified from the most prestigious architectural projects, and was used to roof the huge volume of terraced housing that was built in the same period to house the growing populations of Britain's industrial towns and cities. Its landscape legacy is evident globally, is of unparalleled significance for its type, and represents all phases with high authenticity and exceptional integrity.

Figure 2.116. Penrhyn Slate Quarry provided roofing material for the World Heritage *Royal Exhibition Building* in Melbourne, Australia.

Figure 2.117. These terraces in the London Docklands show how slate roofs enabled the rapid construction of workers' houses during the Industrial Revolution.

Figure 2.115. Huw Llechid Williams, the Penrhyn quarry bugler, lets his workmates know that blasting is about to commence.

2.b.ii The natural environment

Geology

The Component Parts of the Nominated Property represent, and are located in, the most important slate outcrops of Northwest Wales (see Map 2.1). As one of the world's classic deposits, and historically its most significant, many generations of slate workers earned a living from this landscape and made Welsh slate internationally known. Three massive northeast-southwest-trending, sub-parallel linear deposits range over 60km from north to south. Each Component Part and its range of elements, together represent the entire range of process and technology in which slate rock was quarried and mined. The different methods of extraction – stepped galleries, pits or underground – depended on topography, the dip of the slate vein and the disposition of its lines of breakability. All aspects are easily interpreted in this highly legible landscape – above and below ground.

Figure 2.118. The vertical cleavage and bedding plane of the slate rock is evident in this view of Penrhyn Slate Quarry, where the other planes of fracture, the vertical pillaring line and the horizontal foot-joints, are also apparent.

Slate is a hard metamorphosed compacted mud with fissile properties that make it ideal for splitting to form thin, light and strong building products such as roofing elements, cladding, blocks, flooring and lintels, as well as for gravestones and memorials, school-slates, blackboards, urinals, switchboards, billiard tables, furniture and vats for breweries. The metamorphic cleavage (the fissile plane) is the most important plane of fracture but two others are significant: the 'grain' or pillaring line; and the 'foot-joint', across the plane of cleavage. The colour and composition of slate vary considerably, even within a small quarry, but the Cambrian veins of the Ogwen valley, Dinorwig, and Nantlle (Component Parts 1-3), tend to be purple in colour, the Ordovician veins of Gorseddau and Prince of Wales, Ffestiniog and Bryneglwys, grey, and softer (Component Parts 4-6). At Gorseddau and Prince of Wales, the cleavage is coarse, and fewer finely split slates could be made from one block. These quarries concentrated less on roofing elements and more on slab-production.

Understanding how to extract a suitable raw block of slate from the rock-face, whether by hand tools, blasting or wire saws, is part of the working quarryman's skill, and calls for a detailed understanding of geology. Processing a raw block into a commercial product is also skilled work, in particular hand-splitting with hammer and chisel, and is still required by the slate industry as some blocks cannot be processed mechanically even now.

A further characteristic of the industry is that in the diligent exploitation of the highest grade of slate enormous quantities of waste rock was also produced – at least 90% of all that was extracted. The resulting tips form distinctive and monumental elements of the surface landform of *The Slate Landscape of Northwest Wales.*

Topography

The Nominated Property lies in the mountainous areas of the Snowdon massif of Northwest Wales (see Map 2.1). Veins of slate are located in upland areas, at the heads of steep glaciated valleys along which extracted slate could be transported by water, road or rail, to a harbour or to the national railway network.

The Component Parts of the Nominated Property represent the different ways in which quarrymen and engineers responded to challenging topography, not only in the ways in which the rock was worked but also in finding cost-effective means of moving it to where it could be processed, of tipping unworkable rock where it would not compromise future working, and in devising ingenious transport systems utilising gravity to move the finished product. Topography (and hydrology) was also innovatively exploited to provide low-cost energy in the form of water-power.

Hydrology

The Component Parts of the Nominated Property exemplify the use made of the movement and distribution of water for industrial purposes in the mountainous and high rainfall/snowfall environment of Wales. Water was both an opportunity and a challenge. Many quarries had extensive catchment areas; they constructed large reservoirs and extensive channels, and used water to operate shaft- and inclined plane-balances, or to power waterwheels and turbines operating pumps and winding machinery, slate saws, foundry blowers, generators and compressors. Where water was unavailable, steam had to be used, and coal imported at considerable cost.

Hydrography

Although the quarries in *The Slate Landscape of Northwest Wales* are situated in a mountainous landscape, they also lie within a short distance of the sea, a factor which was crucial to commercial success. Component Parts 1, 2 and 3 exported from harbours on the Menai Straits, a narrow stretch of shallow tidal water about 25 kilometres long between the Welsh mainland and the Isle of Anglesey, and which gave access to both Liverpool Bay and the Irish Sea. Component Part 2 also used lake-transport to move its output part of the way to a sea-harbour at Caernarfon. Component Parts 4 and 5 constructed rail links to harbours on Cardigan Bay, the inlet of the Irish Sea which forms the largest bay in Wales, 5 also making use of river-transport to connect with sea-going ships. Component Part 6 is unique in never developing direct rail access to the sea, depending on the national railway network to distribute its output.

Figure 2.119. Padarn Lake enabled slate from Dinorwig (Component Part 2) to make part of the journey to harbour by rowing-boat.

2.b.iii Summary history

The history of *The Slate Landscape of Northwest Wales* divides into three broad periods: an era before the Industrial Revolution which extends from Roman times to the late eighteenth century; a period of dominance from 1780 to 1940, which is the one which makes the most significant contribution to proposed Outstanding Universal Value, and which sub-divides into an expansionist period until 1878, followed by a period of contracting markets culminating in the Great Depression from 1929 to 1940; and thereafter a period of continued decline until the stabilisation of the industry to match demand in the late twentieth century.

Before the Industrial Revolution

Slates from the Cambrian veins, within easy reach of the sea, were quarried for use within Northwest Wales in the Roman period, and were probably exported as far as London. There is little evidence for quarrying thereafter until the second millennium CE, when archaeological and documentary evidence confirms slate was finding favour in high-status dwellings and castles in western England and in Ireland, as well as in the World Heritage *Castles and Town Walls of King Edward in Gwynedd*, the great chain of fortified complexes and borough towns erected by the Anglo-Plantagenet monarch in the thirteenth century to ensure political subjugation to London and to mark the end of independent Welsh rule. Medieval slate-quarrying was probably a part-time occupation for farmers and labourers. Demand grew steadily from 1700 to 1780, but Gwynedd remained until the end of this period a marginal agrarian region, barely touched by the industrial developments which were transforming other parts of Britain and of Europe. Its people dressed in homespun clothes and burnt peat as a fuel. Urban life was restricted to a few small market towns. Wales' ancient Celtic language, one of the Britonnic group, remained the near-universal medium of communication. The translation of the Bible into Welsh in 1588 had enabled the Protestant Reformation to take deep root in Wales, but by the late eighteenth century the reformed Anglican church was itself under pressure from religious Nonconformists who believed that state-supported faith impinged on freedom of conscience, basing their opinions on scripture and reason rather than on tradition and authority. A network of circulating schools sponsored by evangelical churchmen ensured widespread levels of literacy in the Welsh language across the country, making possible the strong and sudden growth of Nonconformist congregations and their chapels in the nineteenth century.

1780 to 1940

The estimated output of British slate increased from 45,000 tons in 1793, of which 58% came from Wales, to 640,700 tons in 1898, of which 77% came from Wales (Gwynedd Archives Service: XM/4874/99). About 90% of Welsh output came from the great quarries in the Snowdonian massif of Northwest Wales, substantially represented by this Nomination.

Before the end of the eighteenth century, slate products from Northwest Wales were already being exported globally. War with France in 1793 and heavy taxes on building materials the following year badly affected slate production in Northwest Wales but in the longer term enabled it to compete with the long-established quarries of the Loire and the Ardennes, as revolutionary turmoil hampered the building trade and brought to a temporary end the demand for roofs for palaces and abbeys. Re-investment by Richard Pennant, Lord Penrhyn (1737-1808), of capital

'Cet ensemble constitue un monument, expression forte d'une civilisation, celle de la société galloise et de la revolution industrielle des îles britanniques, laquelle par sa technologie, ses capitaux et son marché mondial a permis de developper tout le potential productif du Pays de Galles' (This overall unity constitutes a monument which strongly expresses the culture of Welsh society and the industrial revolution of the British Isles, which by its technology, its capital and its access to world markets made it possible to develop the productive potential of Wales) (Professor Philippe Cayla, Président de l'Association de l'Ardoise, 2012, address to ICOMOS-UK 2012 Summer Conference and Annual General Meeting).

derived from his West Indian sugar plantations enabled the consolidation of the older scattered diggings in the Ogwen Valley into Penrhyn quarry, an organised workplace based on a system of stepped galleries (Element 1.1), emulated at Dinorwig (Element 2.1), Gorseddau and Prince of Wales (Elements 4.1-2) quarries. An innovative water-powered mill to cut slate slabs with circular saws (Element 1.2) was opened to serve Penrhyn Slate Quarry in 1802 and a railway system was installed to handle raw blocks for splitting, to tip unproductive rock, and to transport output to the sea (Element 1.3) at a new purpose-built harbour (Element 1.4). William Oakeley (1750-1811) of Plas Tan y Bwlch (Element 5.7) was another improving landlord but preferred to lease out his Ffestiniog quarries. Capitalised partnerships took over Cilgwyn Slate Quarry in Nantlle (Element 3.1) and Diffwys Slate Quarry in Ffestiniog (Element 5.4) in 1800.

A short-lived boom in the 1820s led Thomas Assheton Smith II (1776-1858) to build a railway from his Dinorwig Slate Quarry to the sea (Elements 2.1 and 2.7) and Liverpool financiers to promote a railway (Element 3.9) connecting the Nantlle quarries with a quay at Caernarfon. Growth of the British canal and railway networks facilitated home sales. Repeal of the slate tax in 1831 encouraged bankers in Dublin to fund the 22 kilometre Ffestiniog Railway (Element 5.9), opened in 1836, the longest so far built to serve the industry. Overseas markets expanded considerably. Slates were exported to the West Indies and to the USA from the late eighteenth century. By the 1830s slates were also being sent to Australia. The Great Fire of Hamburg in 1842 gave the Ffestiniog quarries (Elements 5.1-2) their entrée into the German trade. Exports to Germany grew from 12,670 tons in 1867 to 68,490 tons in 1873. The early 1850s ushered in a long period of expansion, reflected in the development of Gorseddau (Element 4.1), Prince of Wales (Element 4.2) and Bryneglwys (Elements 6.1-2) quarries; by 1861 there was an 18-month waiting list for Penrhyn slates, such was the demand. The 504,000 tons of roofing slates produced by the British slate industry in 1877 represented a level never since exceeded. Global exports from Northwest Wales peaked in 1889. Roofing slates and slate-slabs were used on buildings all over the world. The availability of this durable, lightweight material profoundly influenced architectural and building styles, in particular the construction of the low-pitched roofs which became fashionable in the eighteenth century. As quarries opened in other parts of the world, or developed to serve export markets, quarrymen who had learnt their skills in *The Slate Landscape of Northwest Wales* were much in demand as managers and overseers.

Increased demand led to mechanisation. Major developments included the introduction of chain incline ropeways in Nantlle (Element 3.5), water-balance shafts and drainage systems at Penrhyn Slate Quarry (Element 1.1), the building of a water-driven engineering complex (Element 2.5) and an industrial hospital at Dinorwig (Element 2.10), and slate mills and inclined planes powered by steam or water, in all the Component Parts. Circular saw-tables, first introduced in 1802 at Felin Fawr (Element 1.2), were refined and developed, and new technologies adopted, including tunnelling machines. The characteristic 0.6 metre gauge railway which was evolved in the quarries and on the overland systems connecting them to the sea or to the growing mainline network proved a particularly influential technology following trials before an international audience of engineers and promoters on the Ffestiniog Railway (Element 5.9) in 1870.

The quarry settlements which initially took root in the 1820s expanded considerably with the arrival of newcomers drawn to the industry from the immediate rural hinterland. Bethesda (Element 1.6) and Blaenau Ffestiniog (Element 5.6) began to assume the character of towns, with their impressive public buildings and lavish Nonconformist chapels. Engineers and financiers who had been drawn to this very profitable industry constructed new company villages at Nantlle (Element 3.10), Treforys (Element 4.5) and Abergynolwyn (Element 6.3). Barracks were built in many quarries, some of which housed only men (Element 2.3), some entire families (Element 3.5). Quarrymen and their families remained close to the land, tending smallholdings and cottage plots; much of the traditional rural culture from pre-industrial times survived, and the Welsh language was strengthened by the creation of confident new urban and village communities. Quarrymen prided themselves on their rich cultural life, their love of poetry, of music, of prose writing and of debate on social, political, educational and theological matters, all of which were encouraged by their Nonconformist chapels and Anglican churches, libraries, schoolrooms and the *caban* ['cabin'] – their lunch-time meeting-places in the quarries themselves, where they gathered for discussions and recitals.

After 1878 the slate industry of Northwest Wales experienced decline through the stagnation of the United Kingdom building industry, though the export trade remained buoyant. Depression in the 1880s was followed by a brief period of renewed prosperity; by 1898, 16,510 men were employed in the slate industry of Wales, of whom 11,897 (72%) worked in the Nominated Property. New technologies, including electricity (Element 5.3) and catenary 'Blondin' ropeways (Elements 3.2 and 3.8), were introduced to make existing operations more cost-effective, but little new capital was attracted to the industry. The longevity of Welsh slate meant that it had little built-in obsolescence. Slate quarries in the USA and France captured much of the market, and a vogue for flat-roofed buildings lessened demand. The Great Depression (1929 onwards) spelt the end for some Welsh quarries, with others on restricted working. During the 1930s many quarrymen reworked slate tips on their own account to supply a limited market for damp-courses and small roofing elements (Elements 3.1 and 3.3).

Decline and stabilisation – 1940 to present

Depression and two world wars paralysed the building industry and reduced the demand for slate. From 1940 to 1970 *The Slate Landscape of Northwest Wales* continued to experience economic decline, as once-busy quarries became relict sites. Production and demand eventually stabilised, and ambitious modernisation programmes at an extension of the deposits long exploited at Penrhyn Slate Quarry have enabled it to compete with the new slate industries of Spain, China and Brazil.

2.b.iv Global influence – building and history

The Slate Landscape of Northwest Wales embodies an important interchange of ideas in building and architecture that impacted across the world.

Slate is unusual as a quarried stone in that its weight-to-cost ratio makes it worth exporting globally on a significant scale as a roofing element. Welsh slates have been used on buildings all over the world – the dwellings of the rich, the middle classes and the poor, civic buildings, places of worship, places of education, banks, offices, factories and warehouses. They are to be found in every continent and in most countries. They are particularly evident in the context of British imperial expansion and commercial advantage from the late eighteenth century onwards, and contributed to the increasing homogenisation of architecture in the western world in this period. Many excellent examples survive within the Nominated Property, showing the different sizes and qualities that were available, but also including poorer material not worth exporting, all of which together created a vibrant regional vernacular.

Figure 2.120. In *The Slate Landscape of Northwest Wales* itself, even the poorest quality slates, not worth exporting, could find a use, such as these on the roof of the lavatory at Pen yr Orsedd Slate Quarry (Element 3.7).

Though the slate industry of Wales emerged as the market leader in the Victorian period, it is not always possible to distinguish the origin of a slate roof, as there are considerable variations in colour and fissibility even within the same quarry. Slates were also rarely sold by the quarries themselves but by merchants, making it difficult to match source with supply. However, government and corporate archives make clear the enormous amounts produced in Northwest Wales, and the global reach of export.

Slate slabs from slate quarries in Northwest Wales were also exported widely as architectural products. Other exports of slab products are less well documented, though attempts were made to popularise slate furniture in hot climates where beetles and termites attack wood. School writing slates were exported largely across the United Kingdom.

Ships' captains often carried slate speculatively, though slate merchants set up in business in many large ports, and later along canals and railways. Some slate quarry companies in Northwest Wales competed in international exhibitions from 1851 onwards.

Figure 2.121. Slate furniture never proved popular but examples survive at Penrhyn Castle, where slate was used to make an ornamental bed for Queen Victoria's visit.

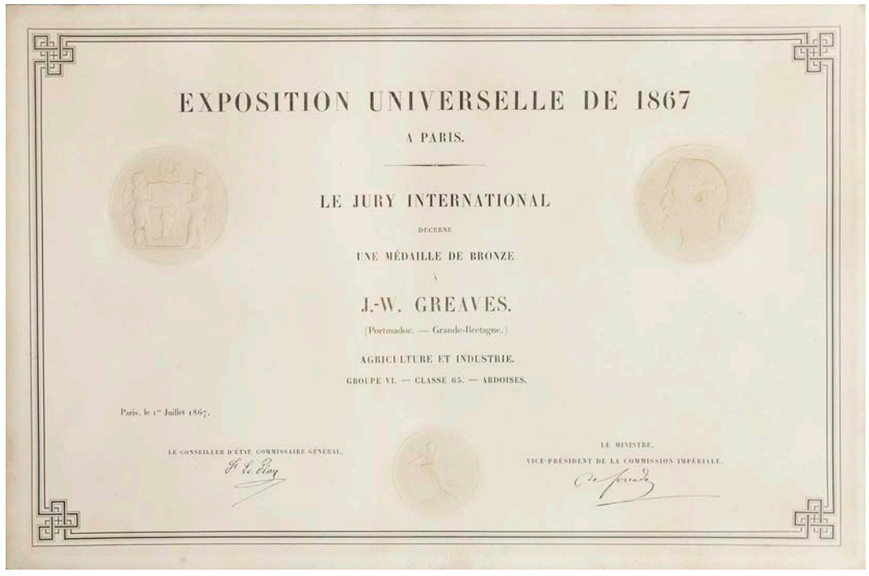


Figure 2.122. Taking part in international exhibitions was an effective way of promoting the qualities of slate from North Wales. J.W. Greaves of Llechwedd Quarry (Component Part 5) won a Bronze Medal at the Paris *Exposition Universelle* in 1867.

The home market – Britain and Ireland

'Spreading suburbs – Although multi-occupancy was common in London, there was a general acceptance that the family dwelling was the norm. Most houses were built in greyish brick with roofs of Welsh slate' (Trinder 2013, 546).

Slate fragments have been identified in Late Roman contexts in London. In Wales, slate was being used to roof high-status dwellings before the Anglo-Norman conquest of the late thirteenth century. The massive thirteenth-century building programme, *Castles and Town Walls of King Edward in Gwynedd*, now a World Heritage site, made considerable use of slate. Slates from Northwest Wales found markets in Cheshire, Shropshire and the hinterland of Bristol, as well as along the eastern coast of Ireland.

By 1738 Nantlle quarries were serving Dublin and London markets. The spread of slated roofs in Ireland down the social scale to the houses of the poorer farmers and labourers benefited the Welsh industry.

Sales of Welsh slates in England were hindered by war with France in 1793, and by a tax the following year. Peace, and the abolition of the tax, made Welsh slate roofs cheaper than ceramic-tiled roofs in London. Canals and the national railway network directly stimulated slate production, and the towns and villages which sprang up along these new lines of communications used slate. These ushered in a period of expansion for the slate industry which lasted until 1878.

Figure 2.123. Welsh slate has been used in Bristol since the Middle Ages. This 1921 photograph of Rupert Street and its environs illustrate the use of Welsh slate in a major city.

Continental Europe

'L'industrie ardoisière en Grande-Bretagne mérite une place toute particulière, en raison de son importance et de son rayonnement mondial'* (The slate industry of Great Britain deserves a special mention because of its importance and its global reach) *(F. Soulez Larivière 1979: 346-59).

The 1794 slate tax temporarily restricted home sales but encouraged trade with northern Europe. Slate was exported to Norway, Sweden, Denmark and Germany. After the great fire of Hamburg in 1842, the Ffestiniog quarries gained a strong foothold in continental Europe. The trade grew significantly from the 1860s, with the completion of the railway network, the end of Bismarck's wars and the lowering and abolition of tariffs.

Figure 2.124. The name of the slate-schooner *Frau Minna Petersen*, owned by Hugh Parry of Porthmadog, reflects the slate-trading links between Northwest Wales and Hamburg (Germany).

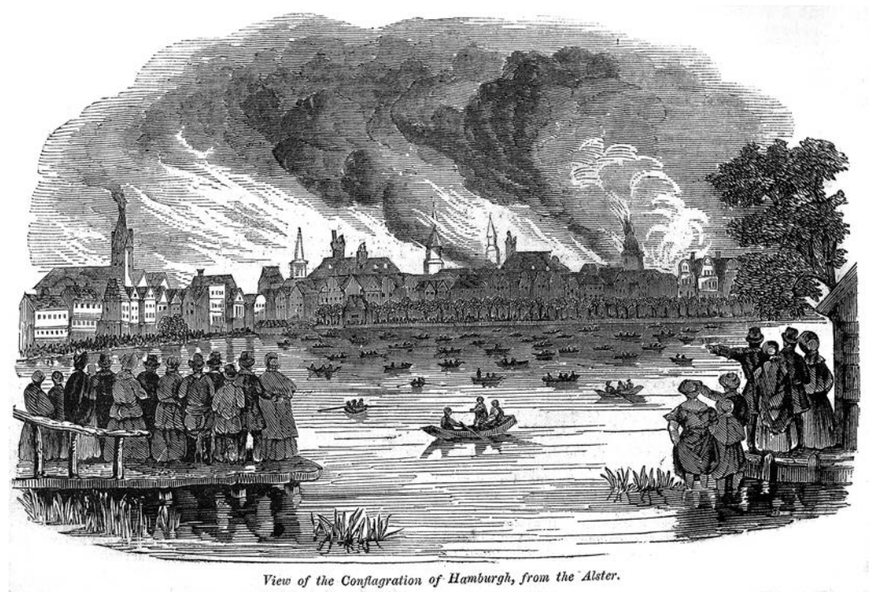


Figure 2.125. The great fire of Hamburg in 1842 destroyed public buildings and over 2,000 homes; rebuilding the city provided an important market for Ffestiniog slate (Lindsay 1974, 194).

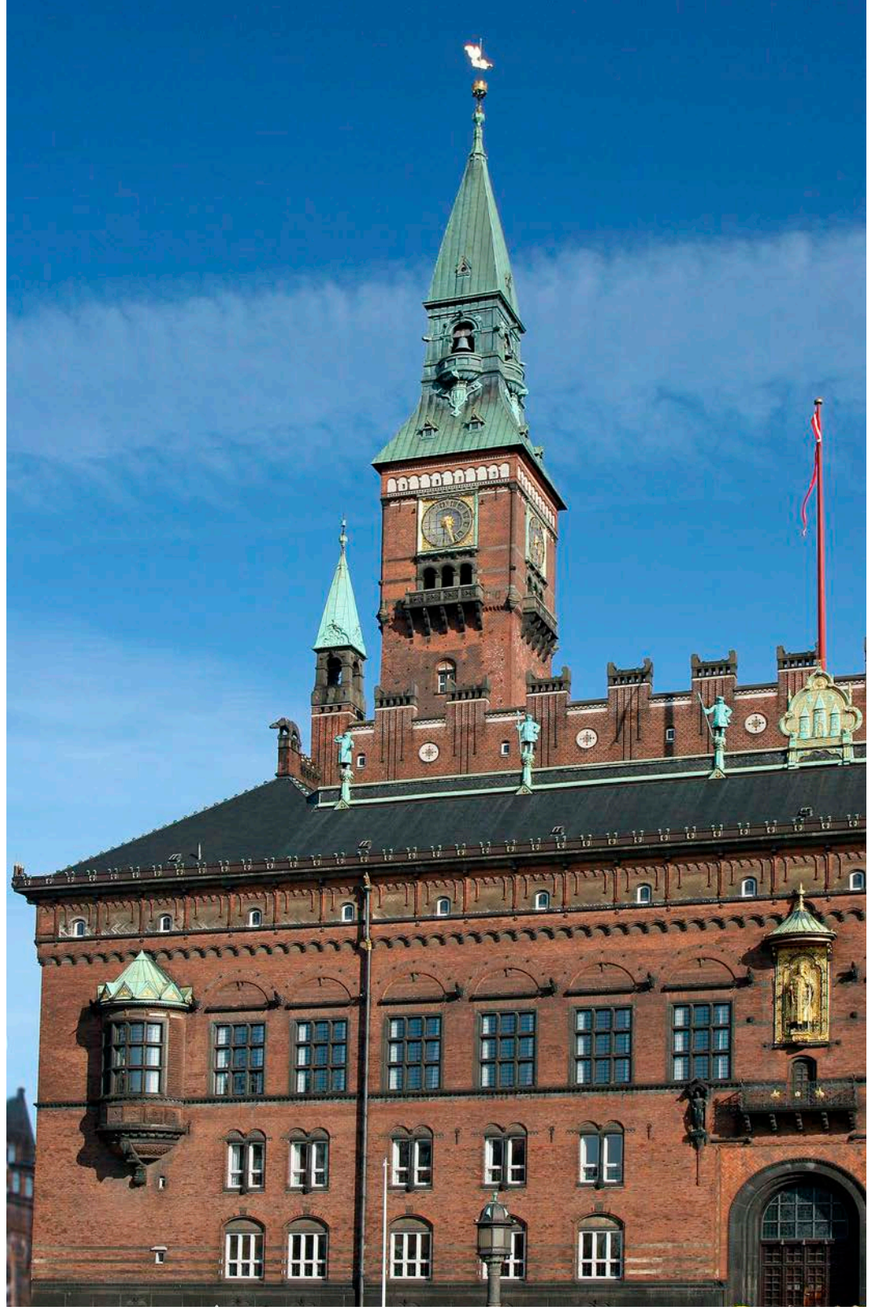


Figure 2.126. The architect Martin Nyrop (1849-1921) used slates from Maenofferen Quarry in Ffestiniog to roof Copenhagen City Hall, completed in 1905 in the Scandinavian National Romantic style.

German builders considered Welsh slate better and cheaper than continental European products. Commercial contacts through the port of Hamburg led to close business and family relationships between Ffestiniog and the slate quarry at Haute Martelange in Luxembourg. Szczecin was another major entrepôt for slate from Wales. Slate was sent inland by rail and water to new markets in Central and Southern Europe. Germany imposed an import duty in 1876, but the trade remained buoyant until 1914.

Figure 2.127. An article in the *Slate Trade Gazette* for 1910 records that Ffestiniog slate slabs were being used in the Alexander Nevsky Russian Orthodox cathedral in Warsaw.

West Indies

Slate from North Wales was used for high status buildings in the West Indies, reflecting the influence of the Penrhyn Estate.

'Around the ruined great houses of Jamaica, fragments of British roof slate can be found, some of which can be traced to particular quarries in North Wales ...' (Atkinson 2006, 132).

American colonies/United States of America

Roofing slates and writing slates have been identified in the context of the earliest phases of English colonisation in Virginia in the seventeenth century.

The United States Department of the Interior's *Preserving Historic Architecture: The Official Guidelines*: 'Evidence of roofing slates have been found also among the ruins of mid-17th century Jamestown. But because of the cost and the time required to obtain the material, which was mostly imported from Wales, the use of slate was initially limited. Even in Philadelphia (the second-largest city in the English-speaking world at the time of the Revolution) slates were so rare that "The Slate Roof House" distinctly referred to William Penn's home built in the late 1600s. Sources of native slate were known to exist along the eastern seaboard from Maine to Virginia, but difficulties in inland transportation limited its availability to the cities, and contributed to its expense. Welsh slate continued to be imported until the development of canals and railroads in the mid-19th-century made American slate more accessible and economical.'

The 1794 British slate tax provided an incentive for exports from North Wales to America, which remained a significant but highly speculative trade until the American Civil War (1861-1865). Welsh slate came increasingly to be used for ordinary structures in the USA. By 1830 half of New York was roofed with slate.

When the price of slates was high, in the 1870s, American quarries gained a foothold in the British and Irish markets, and the USA became a net exporter.

Figure 2.128. The 'Slate Roof House' in Philadelphia was built around 1687 – slate was clearly still an unusual material. It was here that William Penn (1644-1718) wrote the final Charter of Privileges (1701), which reiterated Pennsylvania's commitment to religious liberty. During the American Revolution, members of the First Continental Congress occupied the home, including John Adams and John Hancock. It was demolished in 1868.

Figure 2.129. Henry A. Papprill, after John William Hill. *New York from the Steeple of St Paul's Church, Looking East, South, and West* (1848), coloured aquatint and etching by Henry A. Papprill, after the original by John William Hill. The etching shows the slate roof of St Paul's, built in stages between 1764 and 1796, facing Broadway. Slates are used on St Paul's itself and the older buildings; other materials predominate on newer structures such as Barnum's Museum (left).

Australia

The first roofing slates exported to Australia, in the 1830s, were from the Cambrian veins, where Penrhyn and Dinorwig quarries were regarded as the best. In February 1840, 3,300 Welsh roofing slates reached Adelaide on the vessel *John*, to roof the Quaker meeting house. Penrhyn Slate Quarry exhibited at the Sydney and Melbourne exhibitions of 1879 and 1880. Ffestiniog began to supply Sydney and Melbourne in the 1880s. During the Victoria gold rush (from 1851), complete houses made of slate slab were sent to Australia, and slate roofs were laid on timber houses designed to be assembled in kit form.

Welsh roofing slates competed with native Australian slate, with green slates from Westmorland, Cumberland, and from Whitland Abbey in Pembrokeshire (UK), and with slate from Vermont (USA) and Italy, as well as with the ultimately all-conquering corrugated iron.

Figure 2.130. A Welsh slate roof covers the Friends' Meeting House, a 'Manning Portable Cottage', in Adelaide, built in 1840, shown here in 2002.

Table 2.8 Welsh slate export peaked in 1889		
Destination	*Number (tons)*	*Value £*
Germany	41,547	195,590
Australia	5,444	34,242
Denmark	3,516	34,336
Channel Islands	593	4,387
Austrian territories	516	1,176
Belgium	431	362
Argentine Republic	404	3,229
British South Africa	290	1,889
France	161	406
British West Indies and Guiana	114	817
United States	69	184
British East Indies	58	100
Holland	47	603
Uruguay	32	196
West Coast of Africa	12	82
Spain and Canaries	10	118
British North America	9	45
Bermudas	76	47
Gibraltar	6	60
China	6	51
Turkey	2	20

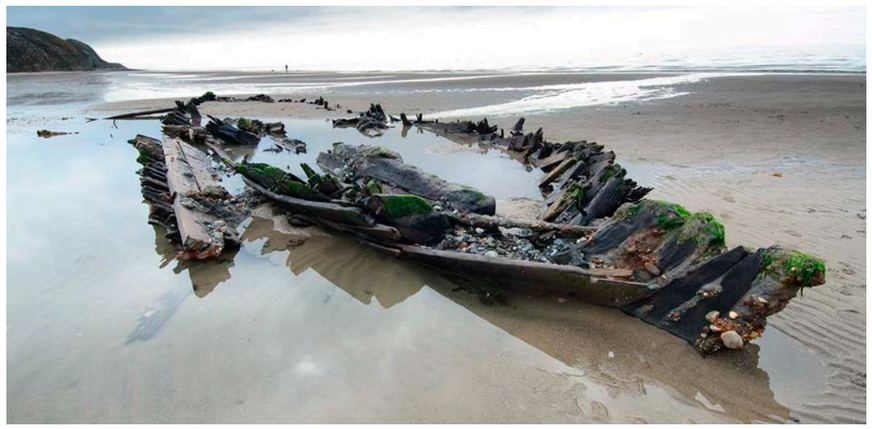


Figure 2.131. Archaeology has identified the remains of wrecks carrying Welsh slate around the coast of Britain and near the mouths of the Elbe and the Oder. These remains of a wooden vessel at Abersoch in Cardigan Bay are probably the *Fosil*, which ran aground in 1889. Broken slates survive in and amongst the timbers.

'Roofing materials changed dramatically as Lord Penrhyn and others began to exploit the slate resources of Gwynedd' (Trinder 2013, 18).

Roofing slates from Wales influenced building and architecture across the world during the Modern period, both for elite and ordinary dwellings.

Figure 2.132. London squares in the eighteenth century were constructed of stock bricks and Baltic pine, heated by Newcastle coal, and roofed with slates from Wales.

Their light weight facilitated Neo-classical low-pitched roofs behind a balustrade or pediment. The prolific English architect Samuel Wyatt (1737-1807) was himself a slate-merchant, profiting from an arrangement whereby he and his brother Benjamin (1744-1818), the agent of the Penrhyn Estate, were supplied from the Quarry (Element 1.1). Samuel Wyatt specialised in medium-sized country houses, but his spare Neo-Classical manner also lent itself to utilitarian buildings. He used slate for every conceivable architectural purpose of his own, as well as selling it to builders and urging its use on professional colleagues. His younger brother James Wyatt

(1746-1813) was a celebrated architect whose work includes Dodington Park in Gloucestershire (UK), the Bath-stone and slate-roofed Graeco-Roman house that served as the model for the Regency country house (Robinson 1973).

Figure 2.133. Purple Penrhyn slate still forms the roof of Dodington Park.

James' contribution was the 'patent slate', a lightweight covering with minimal laps designed to be laid on rafters of a low elevation.

The Federal style in the newly independent United States, as it evolved from colonial Georgian architecture, also encouraged the use of slate.

'The main building shall have a front of two hundred and eighty-two feet and a depth of eighty feet ... The height of three stories, resting on a sub-basement two feet and a basement to be eleven feet high ... The principal story [sic] to be sixteen feet; the whole of said building to be covered with a (Welsh) Slate Roof' – contract for the Federal mint at New Orleans, 1835, designed by William Strickland (Christovich, Toledano and Evans 1995, 13).

Figure 2.134. Samuel Wyatt's Great Barn on the Holkham Hall Estate in Norfolk shows the use of Penrhyn slate on a functional but architecturally ambitious agricultural building.

Terraced housing ('town houses', 'row-houses' or 'linked houses', rows of similar dwellings sharing side walls) lends itself to slate roofing. Its widespread adoption as a means of accommodating working people, in the United Kingdom, the USA, Canada, and Australia, as a consequence of emigration, urban growth and industrialisation, fuelled a demand for slate from North Wales.

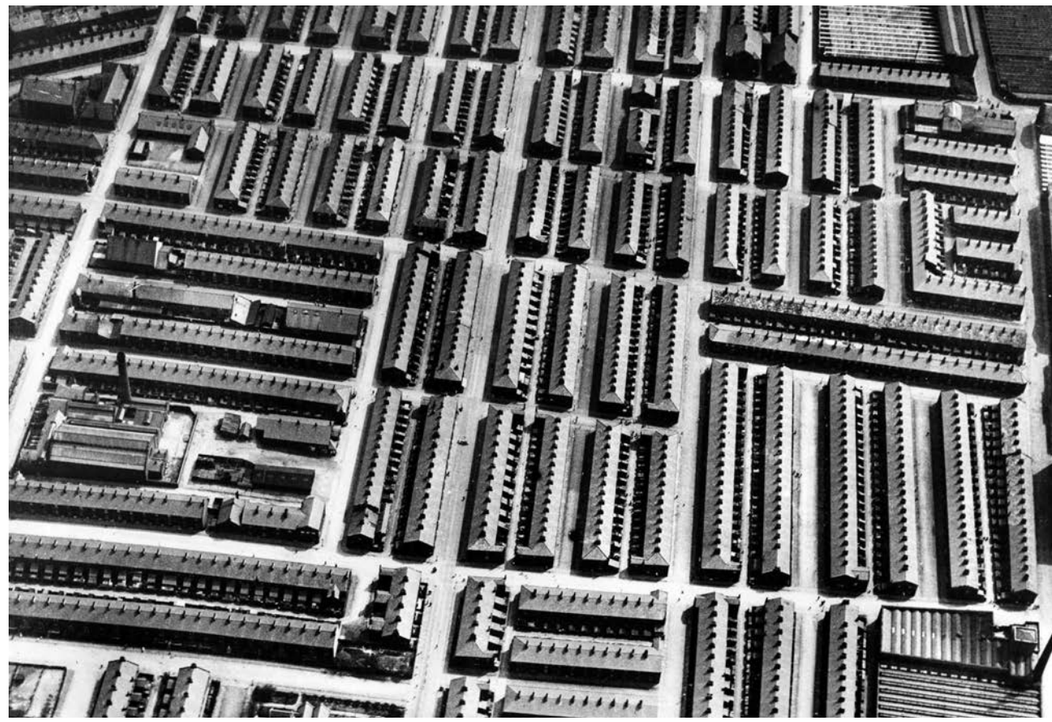


Figure 2.135. A small industrial terraced house might use 2.5 tons of Welsh slate on its roof. Wales' output in the nineteenth century would have covered well over 13,000,000 such homes. This 1925 aerial view is of Burnley in England.

Figure 2.136. A group of Dorothea quarrymen.

The slate quarryman of Northwest Wales

For many years, quarrying for slate in Northwest Wales was mostly part-time work for farmers and farm-labourers. Even after the industry came to be capitalised from 1780 onwards, many quarrymen retained their connection with the land by living on a small-holding. In the boom years from 1856 to 1877, when there was good money to be earned in the quarries, many young men made their way to the raw, burgeoning settlements (Elements 1.5, 1.6, 2.8, 3.10, 3.10, 4.5, 5.6, 6.3) or lodged by the week in barracks (Elements 2.3, 4.1, 4.2) as they found work. Practically all of them came from the immediate rural hinterland. For this reason, the quarryman's language has always been Welsh, and is so to this day.

The slate quarryman's work required agility and some physical strength, but above all it called for intellect. A quarryman had to learn how to study and judge the rock, and work out how best to extract and process it. An apparently mundane role such as piling slate and slabs on a quay (Elements 1.4, 5.8, 5.10) or in a railway yard (Elements 5.9, 6.4) called for a clear logical mind, capable of anticipating when a particular order might need to be accessed and loaded onto a ship or a railway wagon. These jobs went to the best mathematicians.

Not surprisingly, by the middle of the nineteenth century, the slate quarryman was likely to be literate, even literary. Itinerant booksellers always did a good trade when they came to the quarries. Libraries flourished in quarry settlements (Elements 2.8, 5.6). A talent for versifying, singing or debating was admired, and was nurtured in a remarkable institution known as the *caban* (Element 2.2), where the men met for their mid-day meal. The chapels within the quarry settlements promoted discussion groups and educational outreach.

2.b.v Skills-transfer

The Slate Landscape of Northwest Wales represents an important interchange of knowledge and ideas to, from and within this cultural landscape, in terms of the quarryman's craft-skills – his sophisticated knowledge of geology, of the planes of fracture, and of how to blast the rock to best advantage. This took place in two long-established ways – firstly by experienced workers passing on their understanding of complex geological formations to newcomers, often fathers teaching their sons, and secondly by the movement of labour. The ablest workers from Northwest Wales were much in demand to manage slate quarries in Canada, the USA, Ireland, Cornwall, Australia, Italy and Germany.

The 'family' scale of *The Slate Landscape of Northwest Wales* is apparent in confined working spaces, in the *gwaliau* (the separate shelters within which quarrymen split the blocks, then trimmed the split slates – Elements 1.2; 2.1; 3.1; 3.3; 4.1; 4.2), and the barrack buildings arranged as separate cottages (Elements 2.3, 3.5, 3.10, 4.2). Quarrymen retained a considerable degree of autonomy in the way they operated, and had not only to be skilled at working the rock and splitting the slates but also as businessmen. They negotiated the best rates they could with managers, working in groups which sometimes moved from quarry to quarry, as well as often combining slate work with running a shop, a public house or a smallholding.

For most of the nineteenth century and into the twentieth, quarrymen contracted to work a piecework 'bargain', a system with parallels in extractive industries throughout

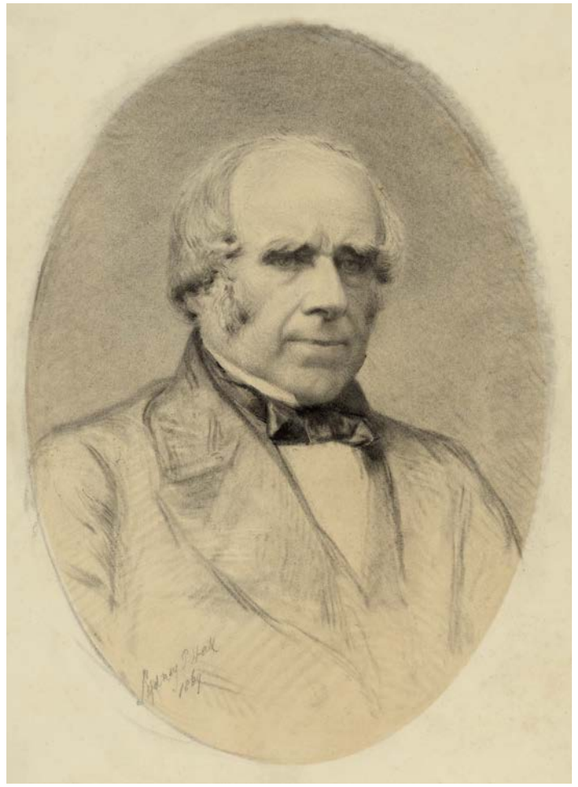


Figure 2.137. Calculating the money owed to each member of a bargain at the end of the month honed the mathematical skills of Griffith Davies (1788-1855), the only slate-quarryman to become a Fellow of the Royal Society. After leaving Cilgwyn Slate Quarry (Element 3.1) in Nantlle for London, with only a rudimentary grasp of English, he gained a reputation as an actuary, analysing statistics to calculate insurance risks and premiums, and as an auditor, entrusted with the accounts of the Bombay and Madras military funds. In 1827 he successfully opposed a parliamentary Bill to enclose common lands near his birthplace which had been settled by quarry families (Element 3.11).

'... a slate-splitter is like a poet ... and contends with the poet on an equal footing at the National Eisteddfod where slate-splitting, music and poetry are stock subjects of rivalry.' (Jones 1981, 74, quoting *Pall Mall Gazette*, 1885)

the world, whereby a group of between four and eight men, often members of the same family, were paid for what they produced. Bargains were reset each month, and quarrymen were awarded 'poundage' if the rock proved poor or the weather made work difficult. The system was open to abuse. Some officials favoured

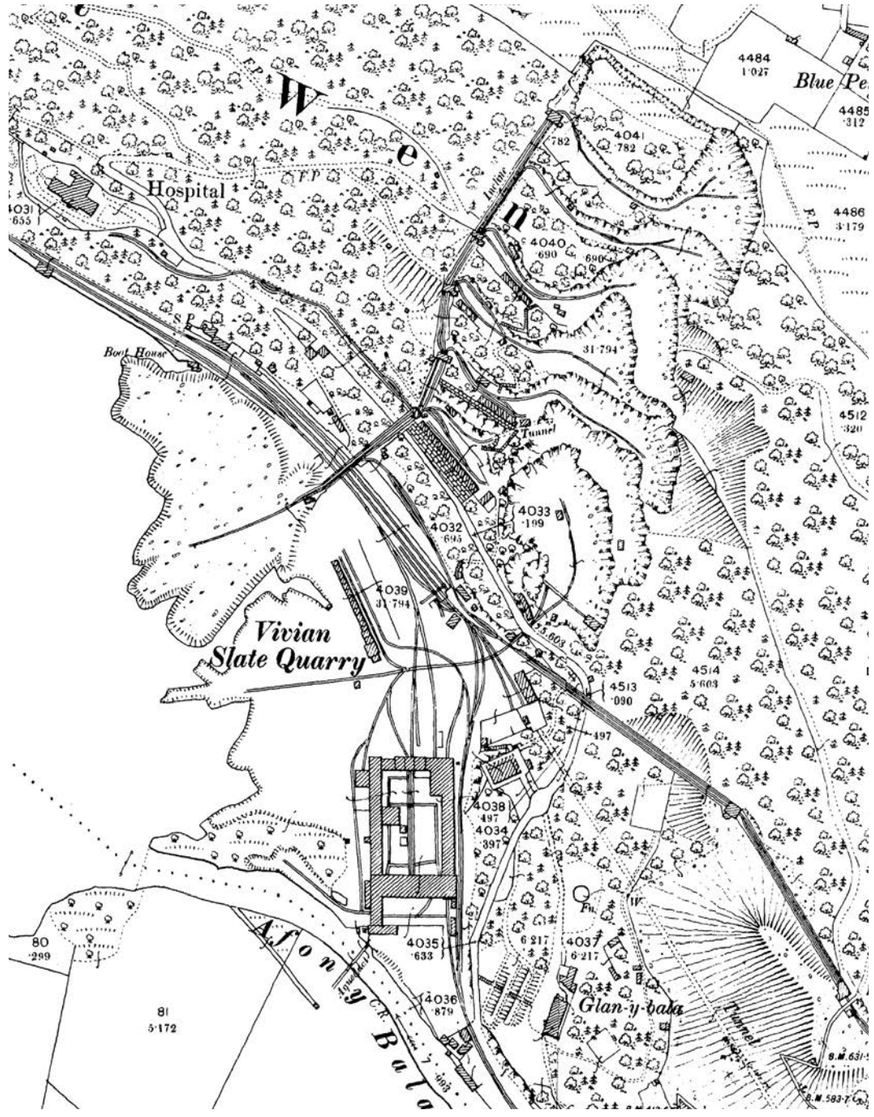


Figure 2.138. The 1900 25 inch to 1 mile ordnance survey map of the Vivian department (Element 2.4) of Dinorwig Slate Quarry illustrates the stepped bench or 'gallery' method of quarrying.

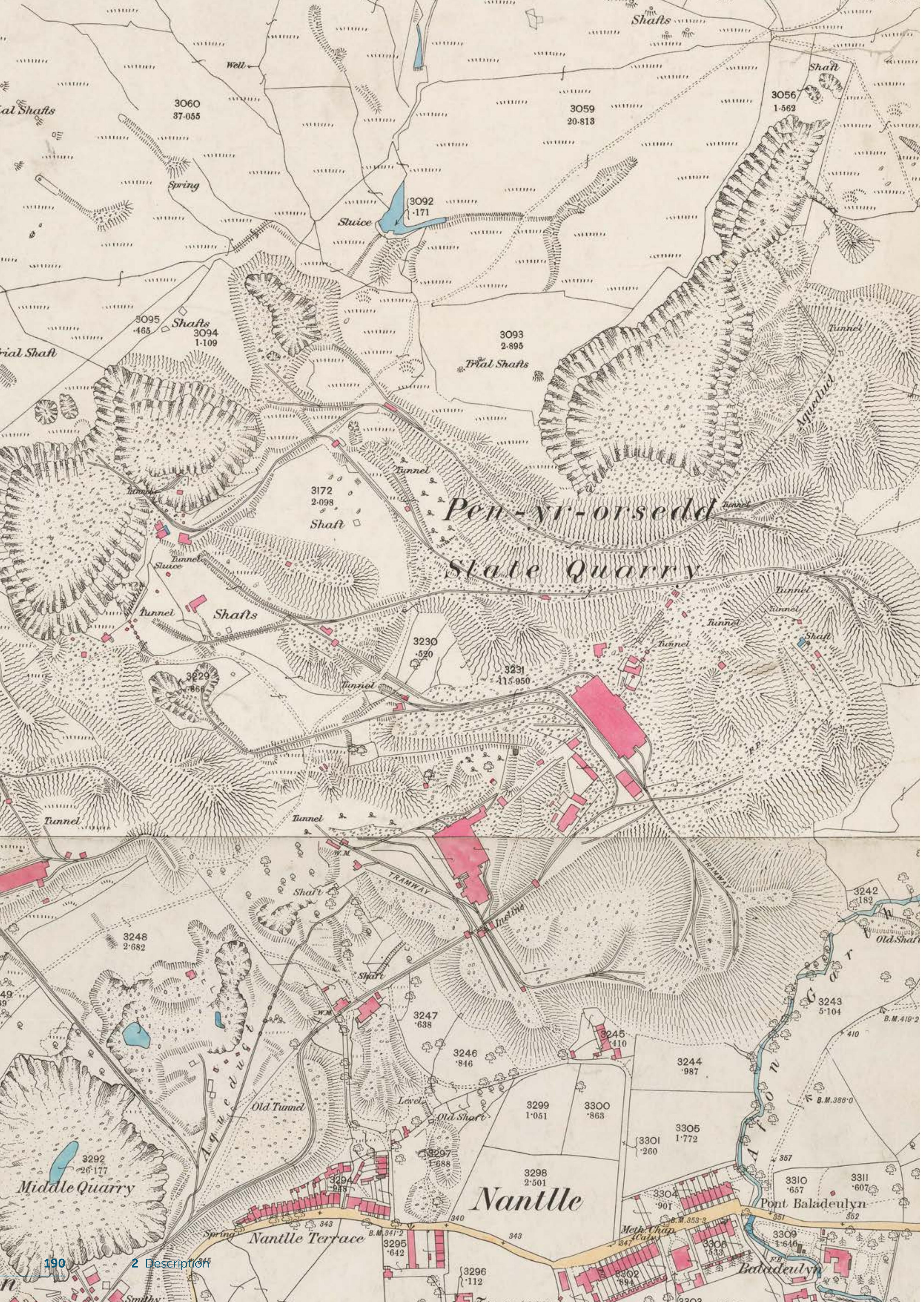


Figure 2.139. The 1889 25 inch to 1 mile ordnance survey map of the Pen yr Orsedd Slate Quarry (Element 3.7) illustrates how the rock was worked in the Nantlle Valley. Rubble and blocks are raised by means of aerial ropeways spanning the pits, then moved by locomotive respectively to the tip-ends for dumping, and to mills to be mechanically sawn and then split by hand.

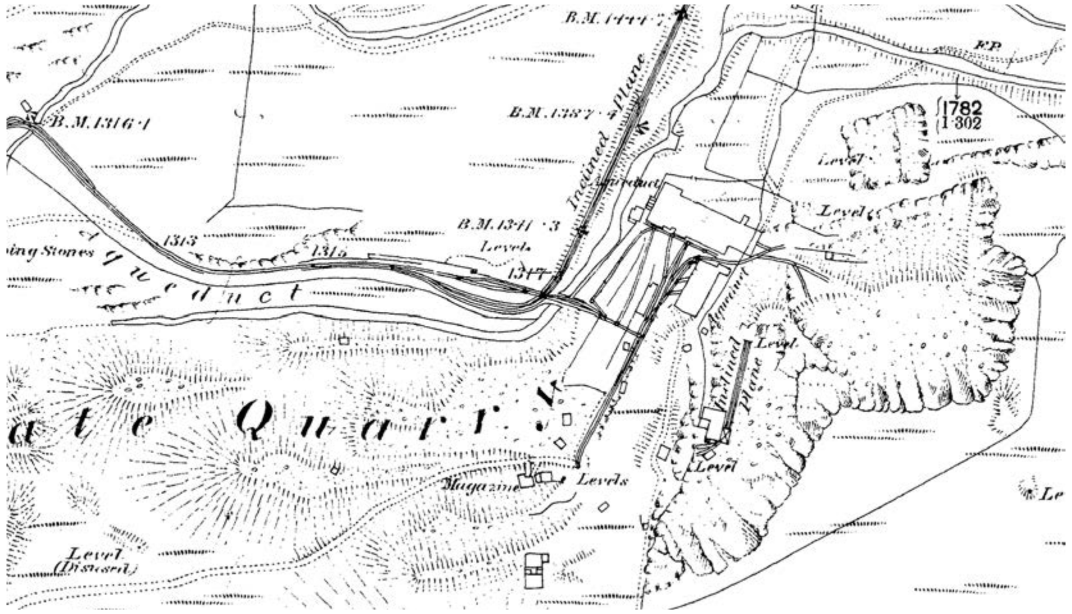


Figure 2.140. The 1889 25 inch to 1 mile ordnance survey map of the Maenofferen Slate Quarry main complex (Element 5.5) shows the typical Ffestiniog approach. Blocks and rubble are hauled out of the mine on an inclined plane. Blocks are sent to a water-powered slate-mill to be mechanically sawn and then split by hand. Rubble is being tipped to the west of the inclined plane to form an apron of waste rock, on which a more ambitious set of mills will shortly be constructed.

churchmen over Nonconformist chapel-goers, or members of one chapel over another. It was resented by men who could not join a bargain, who depended for their living on unskilled labouring and gifts of small blocks that they could split.

Fixed-rate wages and tonnage payments were paid removing unproductive rock, and labourers were paid a day rate. A minimum wage was brought in across the slate industry in 1918.

Quarried blocks were reduced in width and broken into shorter lengths, which at one time required both skill and brute force in wielding a *rhys*, an ash-handled hammer of African oak, at a point on the block where the quarryman considered it would separate. It was gradually superseded by mechanical saws from the 1850s.

A pillared and cross-cut block is split on the plane of cleavage with a hand-held chisel to produce roofing slates, a skill which takes several years to acquire. This process is only now being mechanised but some blocks still require traditional hand-splitting. The splitter sits on a low stool with ankles crossed, resting the block against his thigh, and uses a broad chisel tapped by an iron-bound wooden mallet, successively split it into slates about 1.5 millimetres thick.

The slate-maker then trims the jagged edges, either by a slate-trimming knife or by a machine.

These skills were common to all slate-quarrymen, but they also had to take account of the different quality of the rock they worked, and the different methods by which slate is extracted, according to geology and topography. These included open hillside quarrying, pit-working and mining.

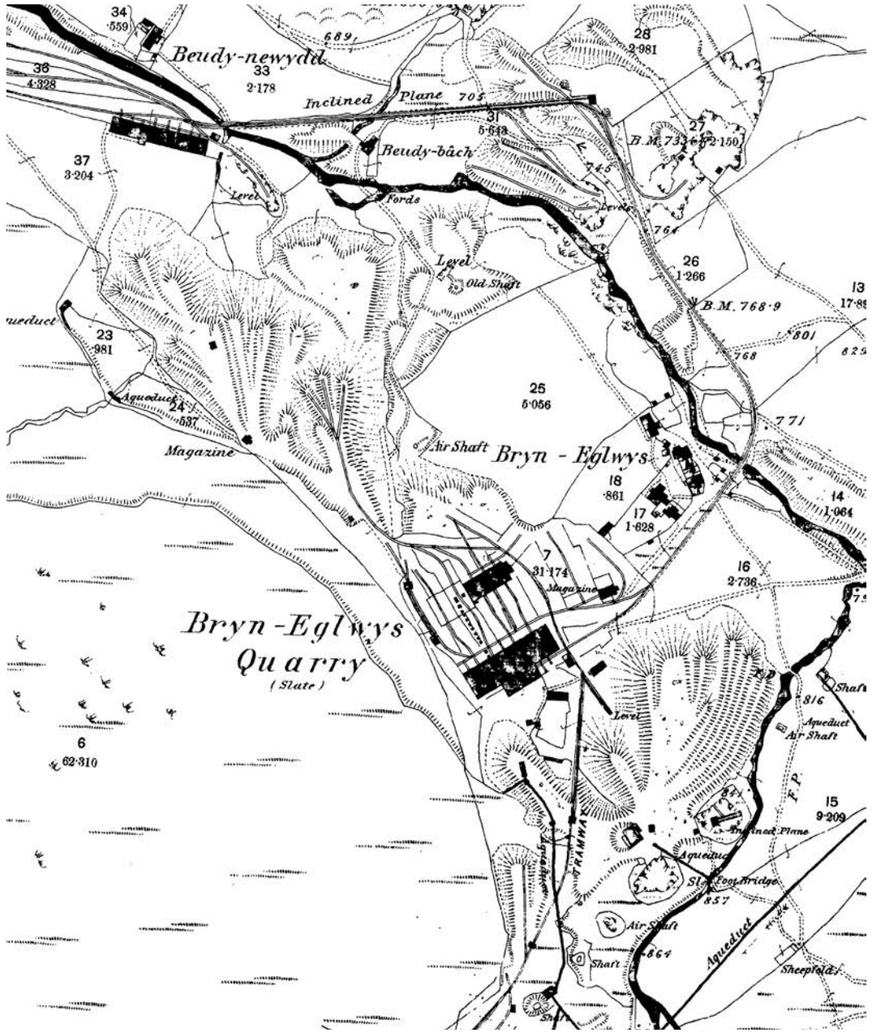


Figure 2.141. At Bryneglwys (Elements 6.1, 6.2), the 1889 22 inch to 1 mile ordnance survey map shows the initial open pits worked by quarrymen from Nantlle. Radiating from the pits to the south-west and the north-east, and below it, are tunnels and underground chambers worked by the next generation to arrive at the quarry – men from Ffestiniog.

From the late eighteenth century, the scattered workings of Penrhyn Slate Quarry (Element 1.1) were organised as a system of regular benches ('galleries') in the hillside, a system widely adopted in many extractive sites, and emulated at Dinorwig (Element 2.1), Gorseddau (Element 4.1) and Prince of Wales (Element 4.2) quarries.

The valley floor and valley-side slate quarries of Nantlle (Component Part 3) were worked as pits with few or no intermediate benches, and Bryneglwys Slate Quarry (Element 6.1) was first opened by skilled quarrymen from Nantlle in this way, before being developed as an underground operation (Element 6.2).

In Ffestiniog (Component Part 5), the vein dips. Slate could initially be worked in open quarries but by the 1820s underground working began, though locally Ffestiniog mines are still conventionally referred to as 'quarries'. The arrival of powerful earth-moving machinery in the mid-twentieth century made it possible to remove large amounts of overburden, with the result that the remaining Ffestiniog operations reverted to open quarrying, and the last underground operations ceased in the 1990s.

Bryneglwys Slate Quarry (Elements 6.1, 6.2) worked two veins of Ordovician slate which dip at between 50° and 60°, with near-vertical cleavage. It was initially worked by quarrymen from Nantlle as an open pit, then by Ffestiniog quarrymen in underground chambers, an instance of internal migration and technology transfer within the Nominated Property.

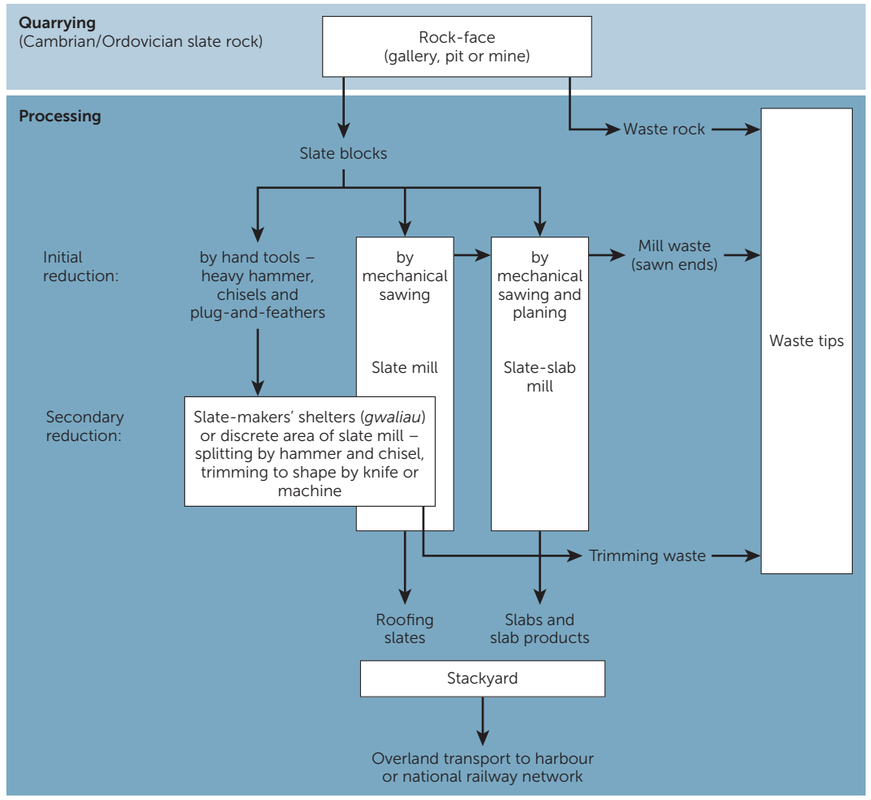


Figure 2.142. This flow-chart illustrates the typical working of a slate quarry and its associated transport system.

This series of photographs taken in 1911 shows the traditional craft-skills of the slate-quarryman.

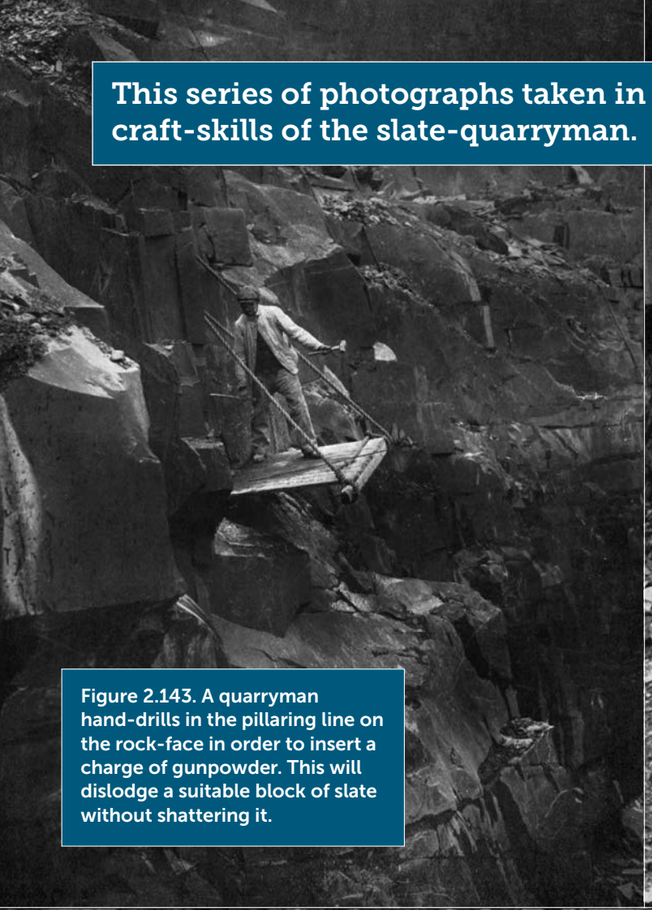


Figure 2.143. A quarryman hand-drills in the pillaring line on the rock-face in order to insert a charge of gunpowder. This will dislodge a suitable block of slate without shattering it.

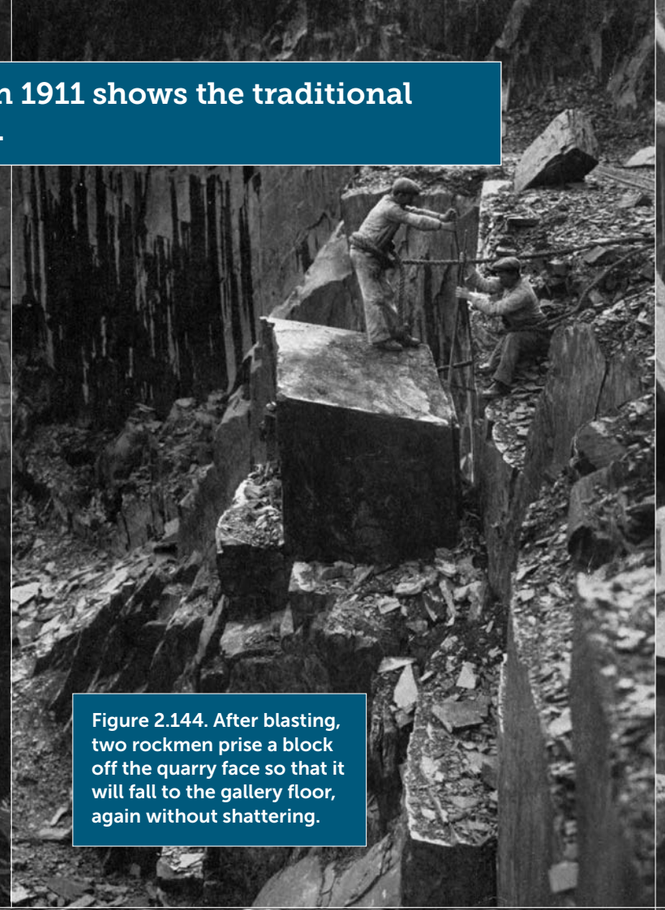


Figure 2.144. After blasting, two rockmen prise a block off the quarry face so that it will fall to the gallery floor, again without shattering.

Figure 2.145. On the floor of the gallery, the block is reduced in size using hand-tools.

Figure 2.146. In a slate mill, the reduced blocks are mechanically squared on a circular saw table powered by a belt drive.

Figure 2.147. These slate-makers are splitting the squared blocks along the plane of cleavage with hammers and chisels then trimming them with a knife. They are now ready for the market.

2.b.vi Global technology transfer – working a slate quarry

Engineering and management

The Component Parts of the Nominated Property also demonstrate the interchange of knowledge and ideas to, from and within this cultural landscape through technology transfer at the level of the professional engineer or manager. This reflects the movement of individuals and the building up of a knowledge-base, local emulation and the movement of capital, as well as paper-based sharing of technical knowledge, participation in international exhibitions and other forms of international visit. All of these are hallmarks of the world-wide Industrial Revolution. Engineers and managers from the Nominated Property sustained considerable influence on the development of slate exploitation elsewhere in the world, especially in England, the USA, Ireland, Germany and Luxembourg.

Organisation of workings

Organising quarries into stepped galleries, pits or mines required close co-operation between quarrymen, managers and engineers. Rock-faces throughout the Nominated Property show evidence of both hand-working and mechanised drilling. Underground working required additional skills, such as tunnelling and securing roofs, channelling water, and specific handling systems. The Welsh methods of working were carefully studied by engineers from the Loire slate industry and were published in the *Annales des Mines*. The use of stepped galleries, though attested in Roman stone-quarrying, came back into general use following its introduction at Penrhyn Slate Quarry (Element 1.1) in the late eighteenth century, and is now common in the industry.

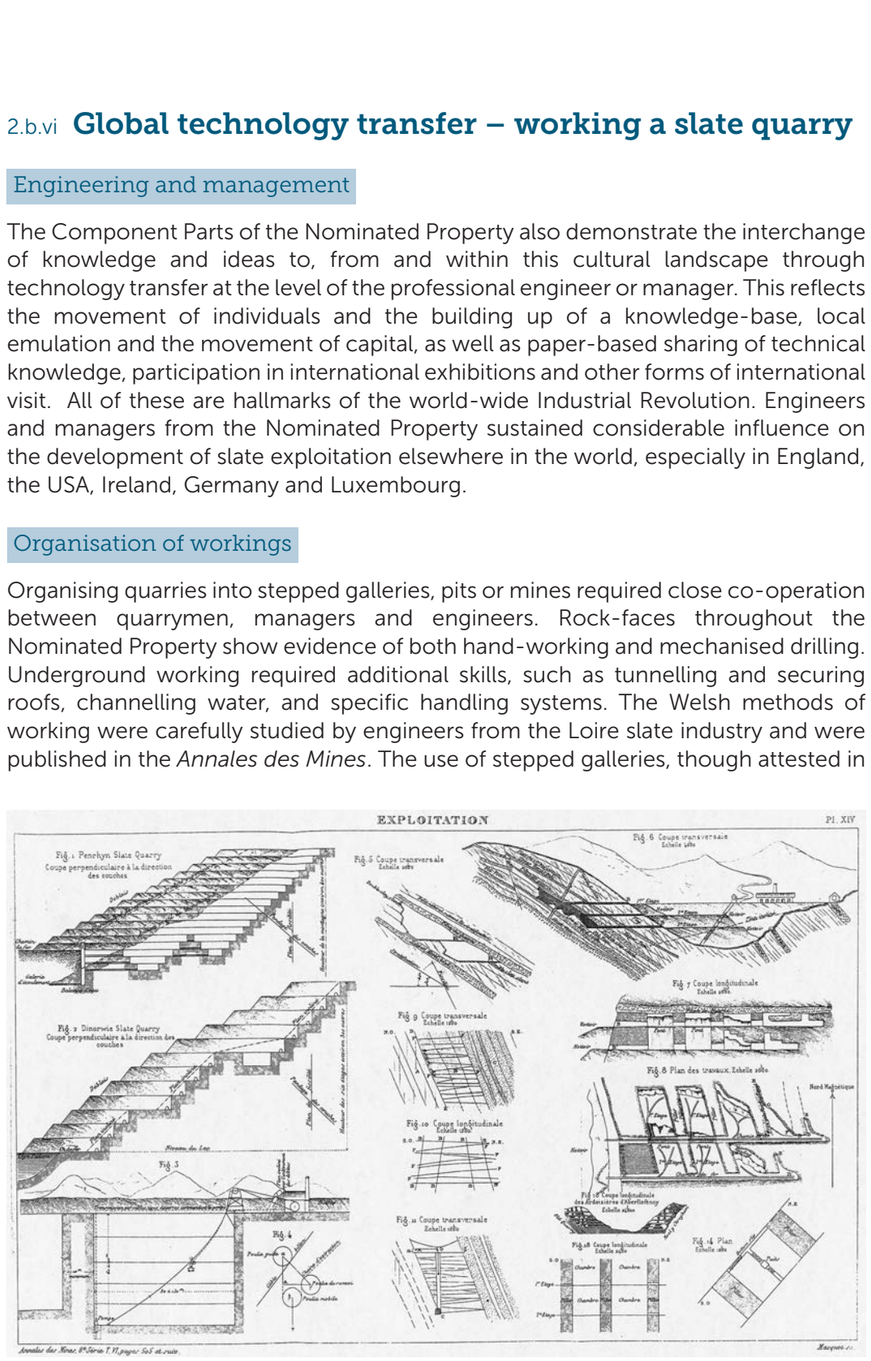


Figure 2.148. The *Annales des Mines* ran a series of articles on the Welsh slate industry in 1884, showing the principal variations in the methods of working. The stepped galleries, inclines and water-balance shafts of Penrhyn and Dinorwig quarries (Elements 1.1 and 2.1) show how quarrymen's skill in working the rock in uniform benches went hand-in-hand with engineering and managerial knowledge to create internal handling systems. Generic cross-sections show a Nantlle valley-floor quarry with a pump system and a chain incline ropeway (Component Part 3), and both surface and underground workings in the inclined beds of Ordovician slate at Ffestiniog (Component Part 5) (Larivière 1884).

Tunnelling

In conjunction with William Fothergill Cooke (1806-1879), inventor of the electric telegraph, the engineer George Hunter (1831-1887) devised a tunnelling machine which was tested underground at Maenofferen Slate Quarry in Ffestiniog in the 1860s, where it has left examples of the circular-section bore it created (Element 5.2). This was an early application of renewable-tip tooling, and left distinctive deep striations in the rock it cuts.

Figure 2.149. This circular-section bore in the underground workings of Maenofferen Slate Quarry (Element 5.2) was created by a Hunter tunnelling machine in the 1860s.

Mechanical processing

Slate quarries in Northwest Wales were innovative in using mechanical processing, initially to meet the growing demand for shaped slabs. By 1802, Penrhyn Slate Quarry's Felin Fawr slate-slab mill (Element 1.2) is known to have been using circular saws for cutting stone; the first place in the world to do so, as far as is known. This narrowly precedes the introduction of circular saws to saw *lignum vitae* at the Royal Navy's Portsmouth Block Mills in 1803 by the engineer Marc Brunel (1769-1849), the machine maker Henry Maudsley (1771-1831) and by the naval administrator Samuel Bentham (1757-1831, brother of the philosopher Jeremy Bentham), a significant stage in the development of mass production systems. Any link between the two sites, perhaps through Benjamin and Samuel Wyatt, is as yet unattested.

The growth and development of mechanical processing can be traced within the Nominated Property from the earliest surviving mills, at Ynysypandy (Element 4.3) and the coeval steam-powered Diffwys mill (Element 5.4), Felin Fawr (Element 1.2), Pen y Bryn / Cloddfa'r Lôn (Element 3.5) and Prince of Wales (Element 4.2). These show evolving practice from the 1850s into the 1870s. Large factory-type mills are evident at Dorothea (Element 3.3), Pen yr Orsedd (Element 3.7) and at the Maenofferen main complex (Element 5.5), where the successive use of water, steam and electric power is evident in the substantial two-bay mill. Australia Mill at Dinorwig Slate Quarry (Element 2.2) was built as late as the 1920s to take advantage of the arrival of electricity to the quarry.

Figure 2.150. The Prince of Wales Slate Quarry (Element 4.2) mill illustrates the transfer of technology within the slate industry of North Wales. It was designed by John Francis (1828-1879) and his father William, (d.1887), managers of Penrhyn Slate Quarry, and built in 1864, when they were also remodeling the Felin Fawr Slate-Slab Mills at Penrhyn (Element 1.2). They represent a development of the design shown here, which Francis tried out experimentally at the Prince of Wales Slate Quarry, even down to the segmental arch doorways (Element 4.2).

Handling of quarried material

Raw blocks and waste rock were moved within the quarries by internal railway systems, including inclined planes, and by chain incline and 'Blondin' ropeways or water-balance shaft. These ensured rapid and effective movement within complex industrial sites that might cover a very large area and involve a vertical distance of over 300 metres between topmost and lowest working floors.

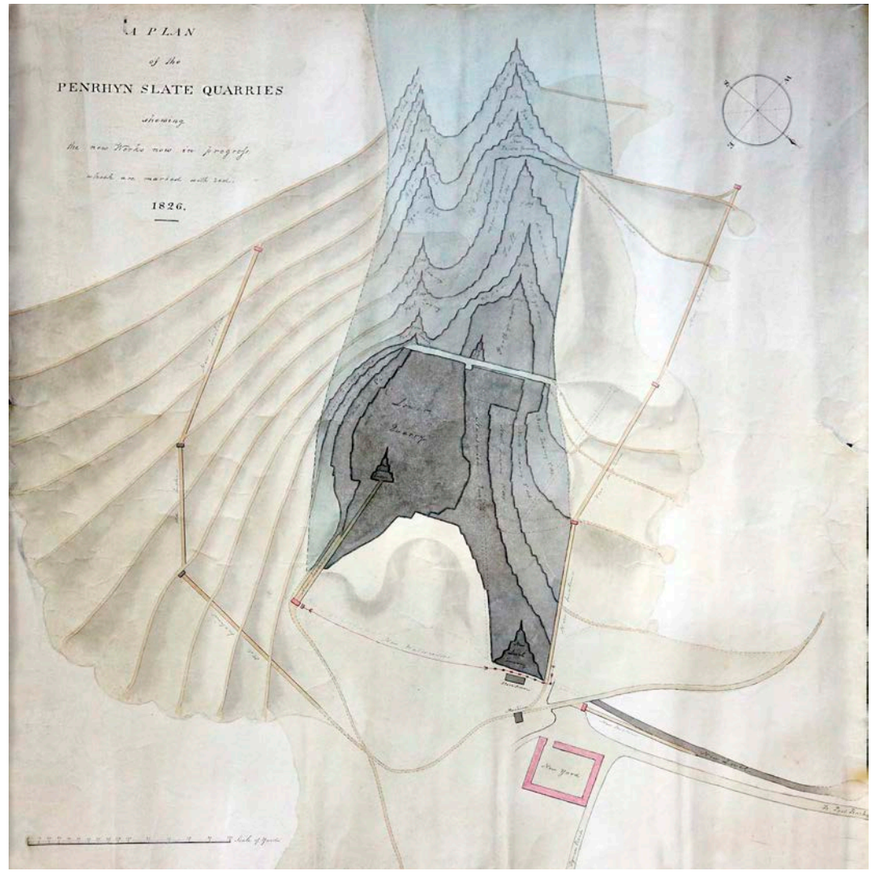


Figure 2.151. This map of 1826 shows how the use of internal railways had already become central to the operation of slate quarries. Counter-balanced inclined planes transport rock from the upper galleries of Penrhyn Slate Quarry, water-powered inclined planes haul rock and waste from the lower pits. The railroad (right) takes the wagons on to the harbour at Port Penrhyn.

The slate railways were some of the earliest developments of the early iron rail systems used to feed iron furnaces in Blaenavon and elsewhere in South Wales, and were nearly always constructed to an approximate gauge of 0.6 metres. They could easily be re-laid and extended as quarrying grew. The use of internal railway systems and inclined planes to handle the movement of blocks, waste rock and finished product begins at Penrhyn Slate Quarry (Element 1.1), where they were introduced in 1801. They subsequently became universal throughout the industry. They were in turn the direct inspiration for the lightly laid railway systems used across the world

on: agricultural estates, factories, prisons, hospitals, saw-mills, sewage farms, mines and collieries, as well as on short-term operations, such as serving trench warfare from 1914 to 1918, clearing wartime bomb sites, on tunnel and reservoir contracts and on large-scale archaeological excavations. The use of inclined planes was common on many early railways and industrial sites from the Industrial Revolution, such as at Ironbridge and in Cornwall but they were even more common features of *The Slate Landscape of Northwest Wales*. Well-preserved examples are evident in Dinorwig (Element 2.1), Dorothea (Element 3.3), Gorseddau (Element 4.1), Prince of Wales (Element 4.2) and Maenofferen (Element 5.5), including both counterbalance types for downwards movement of goods and up-haulage types powered by water-balance, steam and electricity. At Vivian Quarry (Element 2.4) one such incline has been restored to working order by the National Slate Museum. Nowhere else is such a predominance of such systems more evident in their complete historic context.

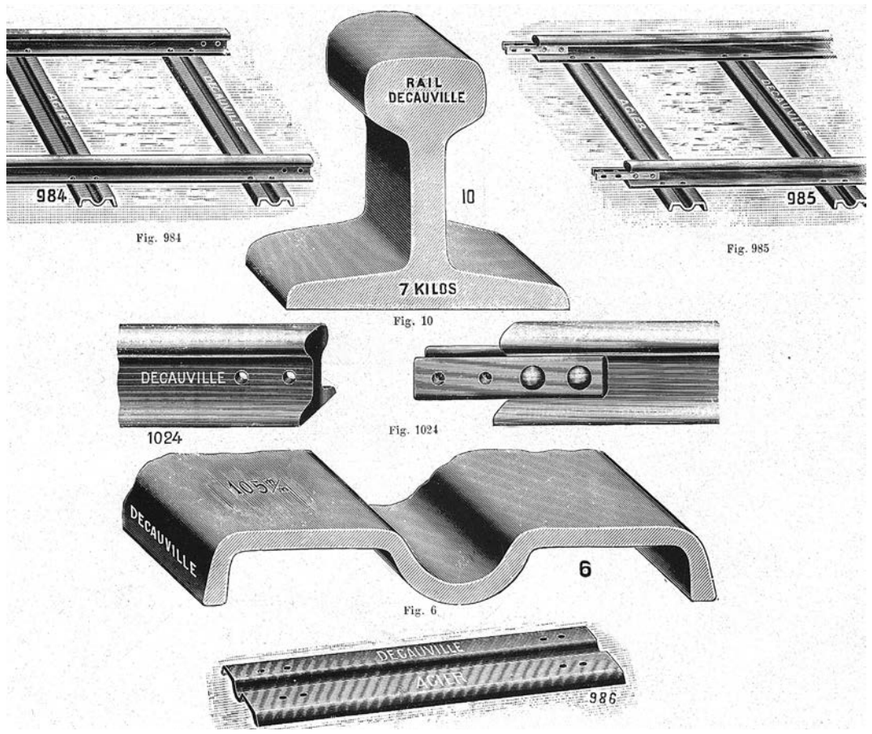


Figure 2.152. The French engineer and Senator Paul Decauville (1846-1922) stated that he had been inspired by the Ffestiniog Railway (Element 5.9) to develop his own brand of portable lightly laid railways for agricultural work (Decauville 1884). Similar systems by other manufacturers were found across the world: those built by Robert Hudson of Leeds, Johannesburg, Kidderpore and Durban dominated the British empire, those of Orenstein & Koppel of Berlin the German-speaking world.

Ropeway systems were in use before the end of the eighteenth century. A simple, early version, unique to the slate industry, was the chain incline, running from an anchorage at the pit bottom to a timber head-gear on a bastion built on the lip of the quarry pit, powered by a water wheel or a steam engine. This pioneering technology has left robust material evidence in Component Parts 3 and 6.

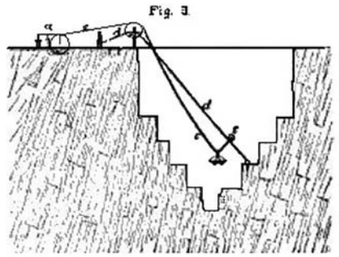


Figure 2.153. The pit-quarries of Nantlle (Component Part 3) reminded Rudolf Nasse, a Prussian visitor in 1869, of the Loire Valley slate quarries in France; he included a sketch of a chain incline ropeway (Nasse 1870, 97).

Figure 2.154. Though Bryneglwys Slate Quarry is the only site in *The Slate Landscape of Northwest Wales* where the technology of the water-driven chain incline can still be seen *in situ* (Element 6.1), sources such as this map of 1862 show it was first evolved at Pen yr Orsedd Slate Quarry in Component Part 3. It was exported to Bryneglwys by Nantlle men. Surviving archaeology and documentary sources such as this are important in establishing how particular technologies functioned and were disseminated. A change of management brought in Ffestiniog quarrymen shortly afterwards; they introduced their own characteristic way of working the rock – from underground chambers.

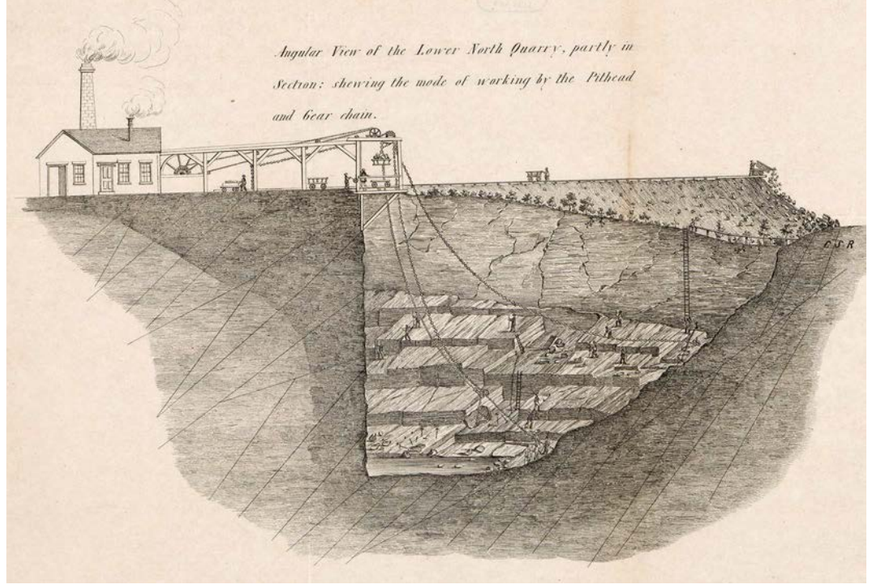


Figure 2.155. This 'angular view' of the Fairhaven Slate Quarry in Vermont (USA) in 1856 shows a steam-powered chain incline introduced by the Welshmen who had emigrated here some years before, and founded their first chapel in 1850.

The 'Blondin' catenary ropeway was introduced from the freestone quarries of Scotland in the late nineteenth century. Surviving examples include both steam and electrically-powered versions (Elements 3.2, 3.8).

Figure 2.156. 'Blondin' ropeways spanned the pit at Pen yr Orsedd Slate Quarry (Element 3.8). Similar systems were not only used in slate and other quarries but also on construction sites, and to load warships with coal. The masts and machinery for the 'Blondin' at Pen yr Orsedd were assembled in Aberdeen, and the electric motors constructed in Edinburgh.

Generating power

The Slate Landscape of Northwest Wales illustrates the successive means of power-generation in the classic industrial period, from water-wheels through steam engines to water-generated electricity in the early twentieth century.

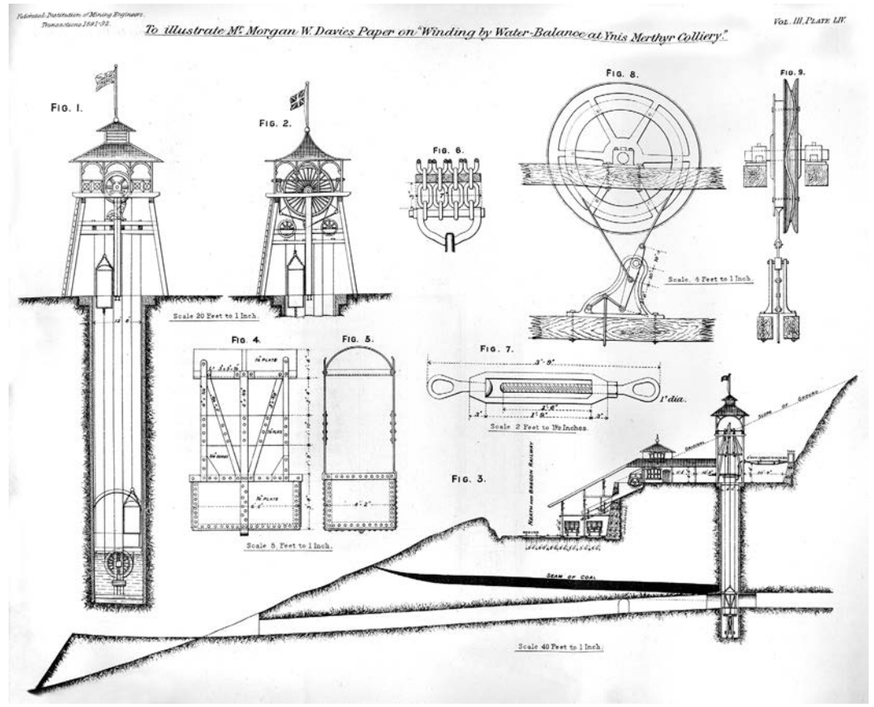

To illustrate Mr Morgan W Davies Paper on "Winding by Water-Balance at Ynis Merthyr Colliery."
Vol. III, Plate LIV.
Fig. 1.
Fig. 2.
Fig. 6.
Fig. 8.
Fig. 9.
Scale 20 Feet to 1 Inch.
Scale 4 Feet to 1 Inch.
Fig. 4.
Fig. 5.
Fig. 7.
Scale 5 Feet to 1 Inch.
Scale 2 Feet to 1 Inches.
Fig. 3.
Scale 40 Feet to 1 Inch.

Figure 2.157. Water-balance shafts to raise wagons became common in the coal industry of South Wales in the 1830s, and were soon adopted in slate quarries on the advice of colliery engineers. This diagram of 1891-2 shows a water balance system at Ynys Merthyr Colliery in the Glamorgan coal-field. Penrhyn Slate Quarry (Element 1.1) made consistent use of them from the 1840s to 1965, when two were preserved. They connect with underground hydraulic features. Experienced miners came from the Staffordshire coal industry to sink the shafts at Penrhyn.

Water-power remained important in the slate industry of Wales from the 1780s to 1940 and subsequently. The Felin Fawr slate-slab mills at Penrhyn and their surviving suspension water-wheels are located over the channeled rivulet which led to the building of the first mill here by 1802 (Element 1.2). The locally constructed water-wheel of 1870 at the Donorwig Slate Quarry Engineering Complex (still operating as part of the National Slate Museum; Element 2.5) represents the ultimate development of an industrial tradition with roots in the third century BCE and the Musaeum of Alexandria; the replacement mechanically connected turbine of 1926 illustrates its successor technology. Other water-driven technology within the Nominated Property includes water-balance shafts and inclined planes (Element 1.1). Dams and water-courses make skilful use of the challenging environment of the area (Elements 1.1, 2.5, 3.6, 4.1, 4.2, 5.3, 6.1), and are an integral part of the industrial cultural landscape. Most still remain in use as part of water-management systems.

Pumping water from the workings

The Slate Landscape of North Wales made use of established pumping technology in ingenious ways. The valley-floor pits of Nantlle (Component Part 3) were particularly prone to water ingress. Two sites in this Component Part illustrate how the challenges were overcome by transfer of technology from the World Heritage *Cornwall and West Devon Mining Landscape*. The pillars and wheel-pits for the flat-rod system at Pen y Bryn (Element 3.6) and the Cornish beam engine by Holman's of Camborne at Dorothea (Element 3.4) provide a contrast in approach and in the way that pumping systems were powered. Both illustrate the influence of water-management technology from the acknowledged industry leaders. The Dorothea engine is the last surviving such machine to be installed from new anywhere in the world.

Figure 2.158. Water-driven rod-engines built to distribute power over a wide area evolved in the Central European mining areas in the sixteenth century, and were widely used in Cornwall and West Devon. They were never common in the slate industry of Wales. Surviving evidence from the most ambitious set-up, at Pen y Bryn Slate Quarry in Nantlle, suggests that it resembled this system at Wheal Martyn china clay works in Cornwall (UK) (shown here) in its use of wrought-iron links rather than timber rods.

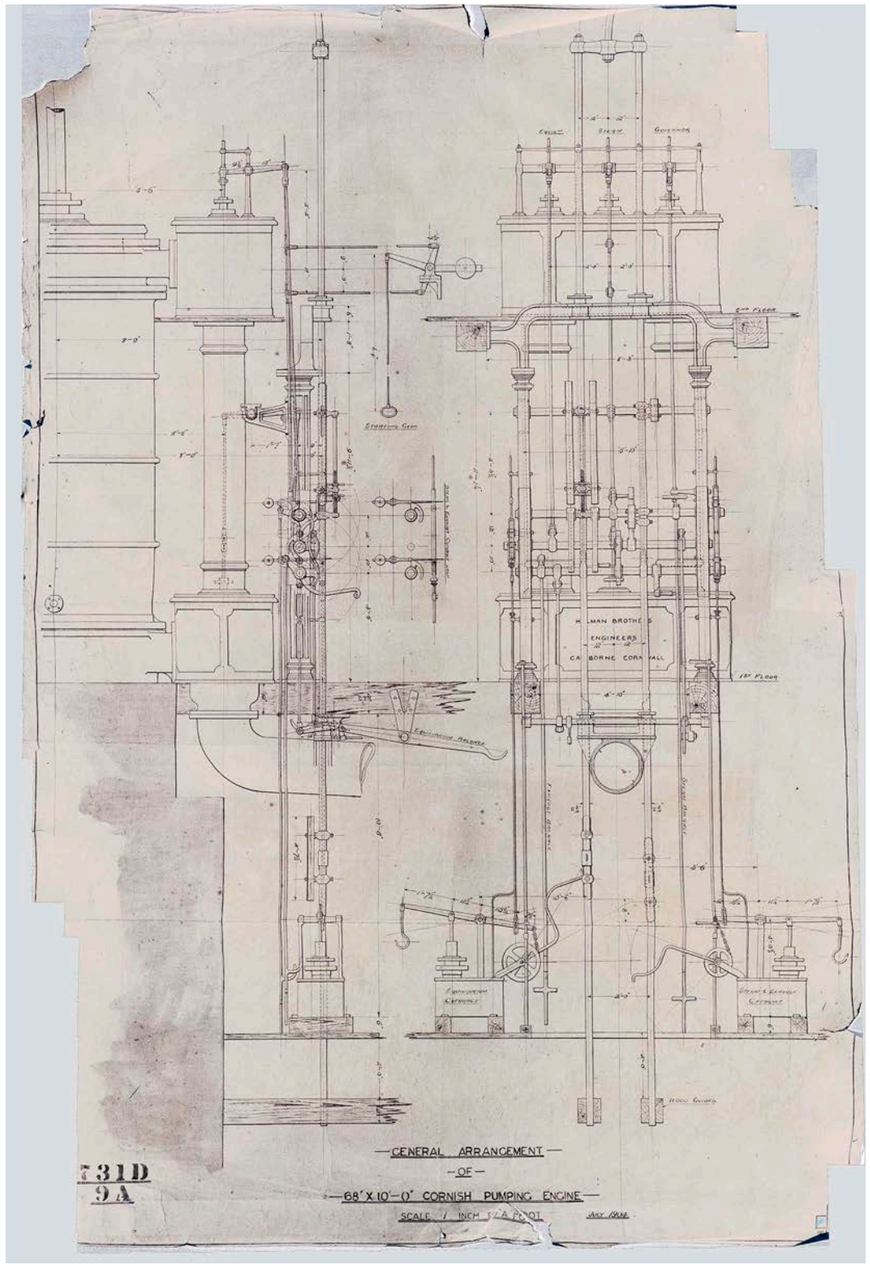
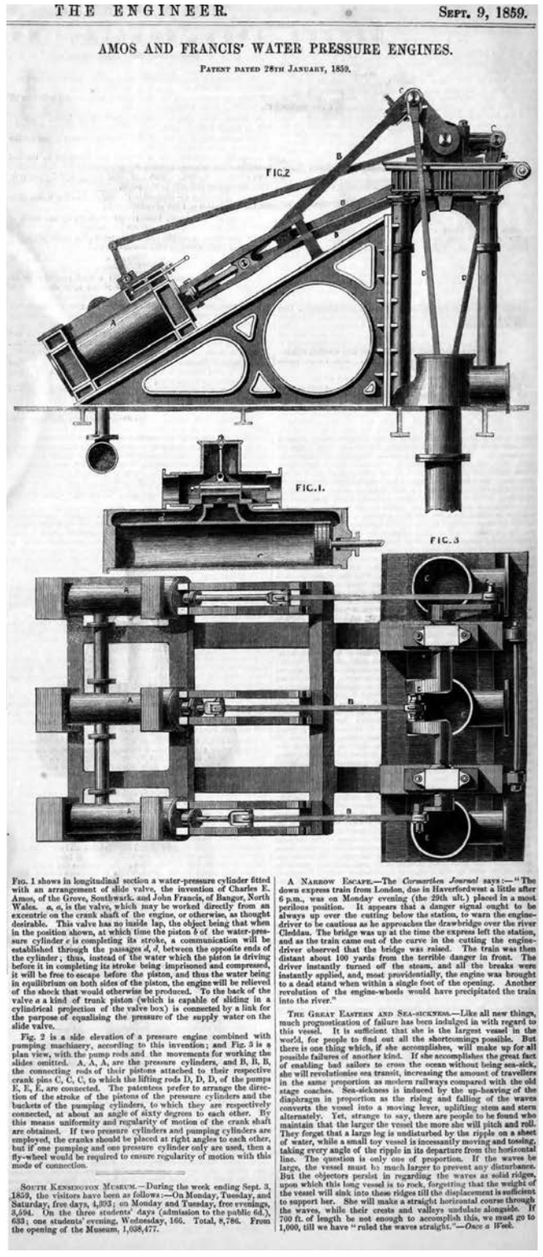


Figure 2.159. The Dorothea Slate Quarry Cornish beam engine represents the final evolution of the steam pumping technology evolved in the World Heritage *Cornwall and West Devon Mining Landscape*. The plans are preserved in the archive of its builders, Holman's of Camborne, in the Cornwall Record Office.

Penrhyn Slate Quarry's hydraulic engine represents a different technology, a positive displacement engine which relies on the incompressible quality of water (Element 1.1). These came into common use simultaneously in France, England and Hungary in the mid-eighteenth century, but saw little development from the mid-nineteenth onwards. It is a rare example in that it is *in situ*, in good condition, still attached to its water-feed system and coupled to its pumps, and is accessible by prior arrangement.



THE ENGINEER. SEPT. 9, 1859.

AMOS AND FRANCIS' WATER PRESSURE ENGINES.

PATENT DATED 28TH JANUARY, 1859.

FIG.2

FIG.1.

FIG.3

FIG. 1 shows in longitudinal section a water-pressure cylinder fitted with an arrangement of slide valve, the invention of Charles E. Amos, of the Grove, Southwark, and John Francis, of Bangor, North Wales. *a*, *a*, is the valve, which may be worked directly from an excentric on the crank shaft of the engine, or otherwise, as thought desirable. This valve has no inside lap, the object being that when in the position shown, at which time the piston *b* of the water-pressure cylinder *c* is completing its stroke, a communication will be established through the passages *d*, *d* between the opposite ends of the cylinder; thus, instead of the water which the piston is driving before it in completing its stroke being imprisoned and compressed, it will be free to escape before the piston, and thus the water being in equilibrium on both sides of the piston, the engine will be relieved of the shock that would otherwise be produced. To the back of the valve *a* a kind of trunk piston (which is capable of sliding in a cylindrical projection of the valve box) is connected by a link for the purpose of equalising the pressure of the supply water on the slide valve.

Fig. 2 is a side elevation of a pressure engine combined with pumping machinery, according to this invention; and Fig. 3 is a plan view, with the pump rods and the movements for working the slides omitted. A, A, A, are the pressure cylinders, and B, B, B, the connecting rods of their pistons attached to their respective crank pins C, C, C, to which the lifting rods D, D, D, of the pumps E, E, E, are connected. The patentees prefer to arrange the direction of the stroke of the pistons of the pressure cylinders and the buckets of the pumping cylinders, to which they are respectively connected, at about an angle of sixty degrees to each other. By this means uniformity and regularity of motion of the crank shaft are obtained. If two pressure cylinders and pumping cylinders are employed, the cranks should be placed at right angles to each other, but if one pumping and one pressure cylinder only are used, then a fly-wheel would be required to ensure regularity of motion with this mode of connection.

SOUTH KENSINGTON MUSEUM.—During the week ending Sept. 3, 1859, the visitors have been as follows:—On Monday, Tuesday, and Saturday, free days, 4,393; on Monday and Tuesday, free evenings, 3,594. On the three students' days (admission to the public 6d.), 633; one students' evening, Wednesday, 166. Total, 8,786. From the opening of the Museum, 1,658,477.

A NARROW ESCAPE.—The *Carmarthen Journal* says:—"The down express train from London, due in Haverfordwest a little after 6 p.m., was on Monday evening (the 29th ult.) placed in a most perilous position. It appears that a danger signal ought to be always up over the cutting below the station, to warn the engine-driver to be cautious as he approaches the three bridges over the river Cleddau. The bridge was up at the time the express left the station, and as the train came out of the curve in the cutting the engine-driver observed that the bridge was raised. The train was then distant about 100 yards from the terrible danger in front. The driver instantly turned off the steam, and all the breaks were instantly applied, and, most providentially, the engine was brought to a dead stand when within a single foot of the opening. Another revolution of the engine-wheels would have precipitated the train into the river."

THE GREAT EASTERN AND SEA-SICKNESS.—Like all new things, much prognostication of failure has been indulged in with regard to this vessel. It is sufficient that she is the largest vessel in the world, for people to find out all the shortcomings possible. But there is one thing which, if she accomplishes, will make up for all possible failures of another kind. If she accomplishes the great fact of enabling bad sailors to cross the ocean without being sea-sick, she will revolutionise sea transit, increasing the amount of travellers in the same proportion as modern railways compared with the old stage coaches. Sea-sickness is induced by the up-heaving of the diaphragm in proportion as the rising and falling of the waves converts the vessel into a moving lever, uplifting stem and stern alternately. Yet, strange to say, there are people to be found who maintain that the larger the vessel the more she will pitch and roll. They forget that a large log is undisturbed by the ripple on a sheet of water, while a small toy vessel is incessantly moving and tossing, taking every angle of the ripple in its departure from the horizontal line. The question is only one of proportion. If the waves be large, the vessel must be much larger to prevent any disturbance. But the objectors persist in regarding the waves as solid ridges, upon which this long vessel is to rock, forgetting that the weight of the vessel will sink into these ridges till the displacement is sufficient to support her. She will make a straight horizontal course through the waves, while their crests and valleys undulate alongside. If 700 ft. of length be not enough to accomplish this, we must go to 1,000, till we have "ruled the waves straight."—*Once a Week*.

Figure 2.160. Hydraulic (or water-pressure) engines operate in a similar way to a steam engine, by the action of an impellent force under pressure on a piston in a cylinder. The first one at Penrhyn Slate Quarry (Element 1.1, see Figure 2.15) featured in an article in *The Engineer*, the leading English-language professional journal of its time, on 9 September 1859. They were devised by John Francis (1828-1879), the quarry manager, in conjunction with Charles Amos (1806-1882) who began his working life on the fenland drainage in the east of England, and who had a long and distinguished career as an engineer, constructing the hydraulic jack which raised the tubes on Robert Stephenson's Britannia Bridge, which connects the mainland of Wales to Anglesey.

Maintenance and repair

Craftsmen, technicians and engineers in the slate industry of North Wales were ingenious and self-reliant. They could turn to local engineering firms, including the Ffestiniog Railway, for some machinery, but the larger quarries, including Penrhyn and Dinorwig, operated their own engineering complexes to maintain, repair and sometimes construct machinery. Penrhyn Slate Quarry was served by a foundry and workshops at Felin Fawr slate-slab mill (Element 1.2). The Dinorwig Slate Quarry engineering complex is now the National Slate Museum (Element 2.5). It was designed to impress; the quadrangular layout recalls not only earlier engineering practice but also the stable-courtyard of a great British landed estate.

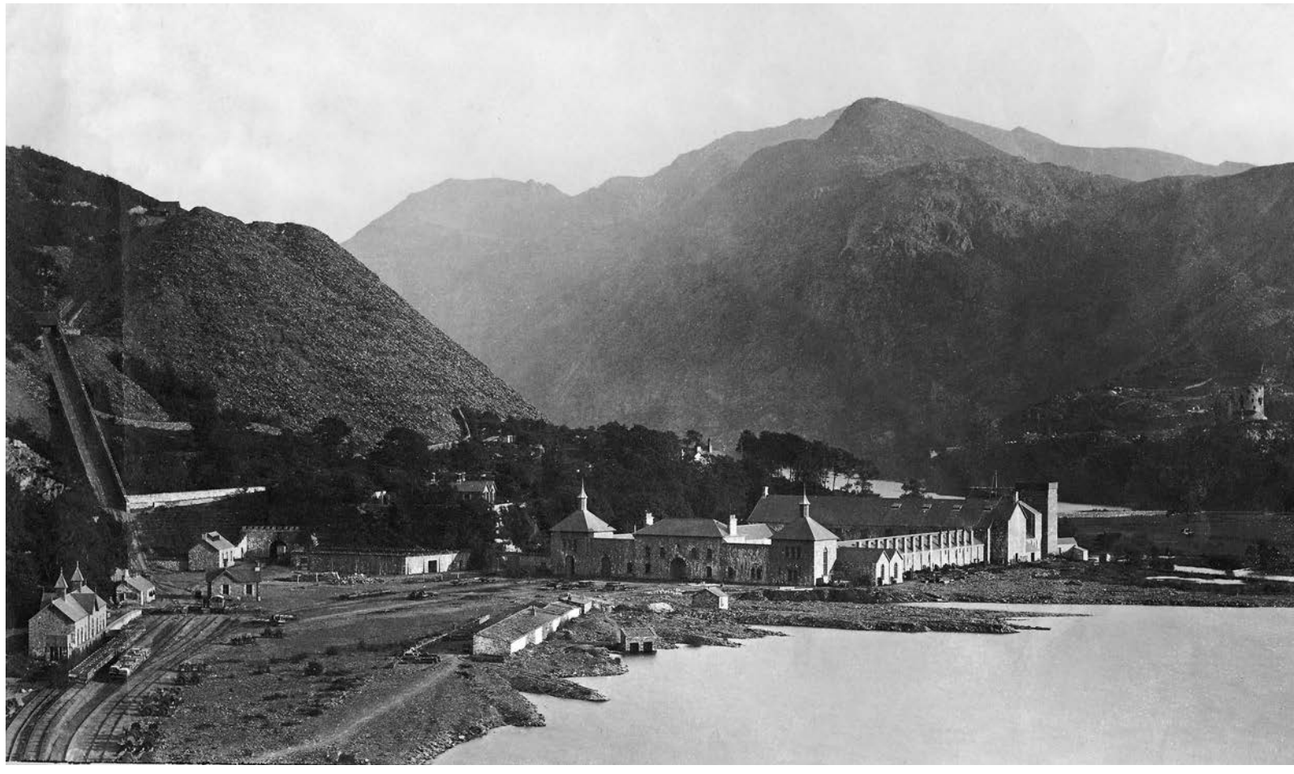


Figure 2.161. The Dinorwig Slate Quarry engineering complex (Element 2.5) has seen little change since opening in 1870. As the National Slate Museum, it has been sensitively conserved. Traditional skills of blacksmithing, carpentry, founding, pattern-making and mechanical engineering were taught to apprentices as they were on a great landed estate, and were handed down over the generations.

2.b.vii Global technology transfer – railway-building

The Slate Landscape of Northwest Wales represents an important interchange of ideas and knowledge in the transfer of railway technology.

The Ffestiniog Railway '...one of the most magnificent works in the Kingdom. Indeed while we admire the Liverpool railroad for the immensity of the undertaking, the Menai bridge for its symmetry of magnificence & the Aquaducts (sic) at Llangollen & Chirk for similar reasons, no person I am certain having viewed these & inspected the Quarry railway will for a moment hesitate to admit that its proportion of these desiderata to be less ..' (Thomas Letts, *Tour of North Wales, August-September 1834* [National Library of Wales manuscript 22341B (1834) fol 53v])

Slates were initially transported to ports and harbours (Elements 1.4, 5.8, 5.10) by pack-horse, by horse-and-cart or by lake- and river-boat, or by a combination of these methods. As output grew, the challenging mountainous landscape of Northwest Wales called for more innovative and cost-effective solutions. The answer lay in narrow-gauge railways (Elements 1.3, 2.7, 3.9, 4.4, 5.9, 6.4). The railways' ingenious use of topography to assist operations by means of inclined planes and continuous down-gradients, and their innovative adoption of mechanical traction and provision of passenger services, form a remarkable technical achievement which was imitated worldwide. Several of the distinctive quarry settlements grew up around them, such as Deiniolen/Clwt y Bont (Element 2.8) and Tan y Grisiau (Element 5.6). Two of the most significant railways, the Ffestiniog (Element 5.9) and the Talyllyn (Element 6.4), are now major heritage attractions with an international profile.

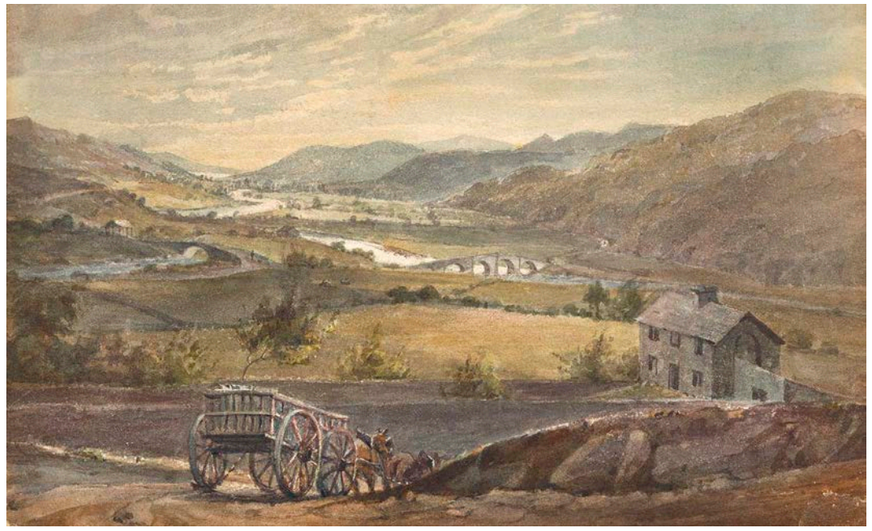


Figure 2.162. The modern road network in Component Part 5 follows the routes built to move slate. Here a cart laden with slate makes its way down to a wharf on the Dwyryd river in the distance (Element 5.8), where the load will be transferred to a small boat before being loaded on a sea-going ship.

The architect and slate-merchant Samuel Wyatt assisted his brother Benjamin to devise a 0.6 metre gauge cast-iron railroad to serve the slate quarries on the Penrhyn Estate for which Benjamin was responsible (Element 1.3). It recalls typical canal arrangements, such as the use of inclined planes on the same principle as a flight of locks. When it was completed in 1801, it was the longest iron edge-railway in the world, the first such railway built for the mass transport of quarried stone, and is the design-ancestor of all subsequent narrow-gauge railways.

The *Annales des Arts et Manufactures* described the Penrhyn Railroad in its edition of 30 Messidor year 12 (1804) '... inventé par M. Benjamin Wyatt ... récemment employé dans le Carnarvonshire, depuis les carrières d'ardoises de Lord Penrhyn, jusqu'au Port Penrhyn où on les embarque; la longueur de ce chemin est de six milles un quart (mesure anglaise); la pente est d'un huitième de pouce par pied; il a été commencé en Octobre 1800 et achevé en juillet 1801' (89-90).

'... invented by Mr. Benjamin Wyatt ... recently employed in Caernarvonshire, from the slate quarries of Lord Penrhyn, to Port Penrhyn where they are shipped; the length of this road is six miles and a quarter (English measure); the slope is one-eighth of an inch per foot; it was started in October 1800 and completed in July 1801.'

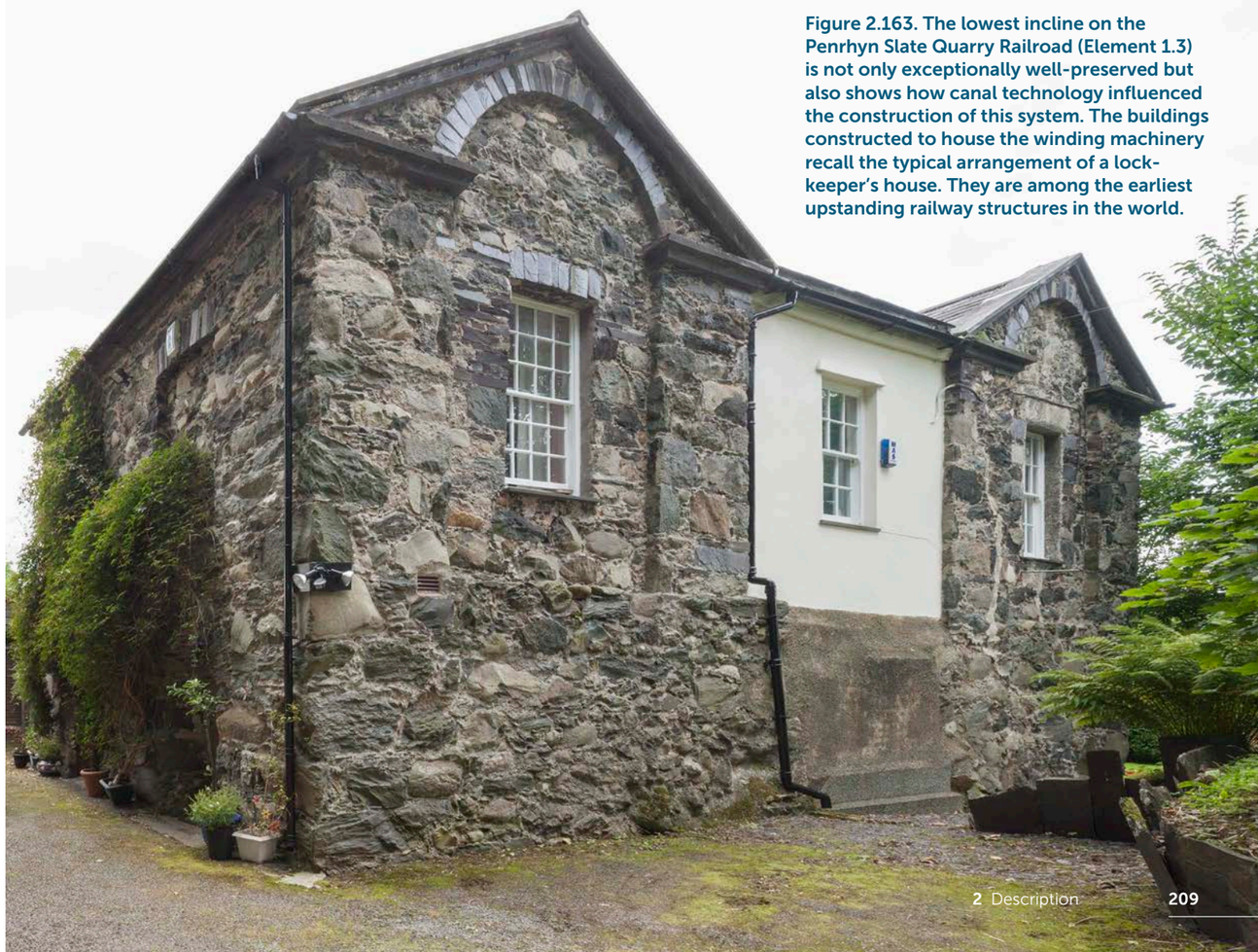


Figure 2.163. The lowest incline on the Penrhyn Slate Quarry Railroad (Element 1.3) is not only exceptionally well-preserved but also shows how canal technology influenced the construction of this system. The buildings constructed to house the winding machinery recall the typical arrangement of a lock-keeper's house. They are among the earliest upstanding railway structures in the world.

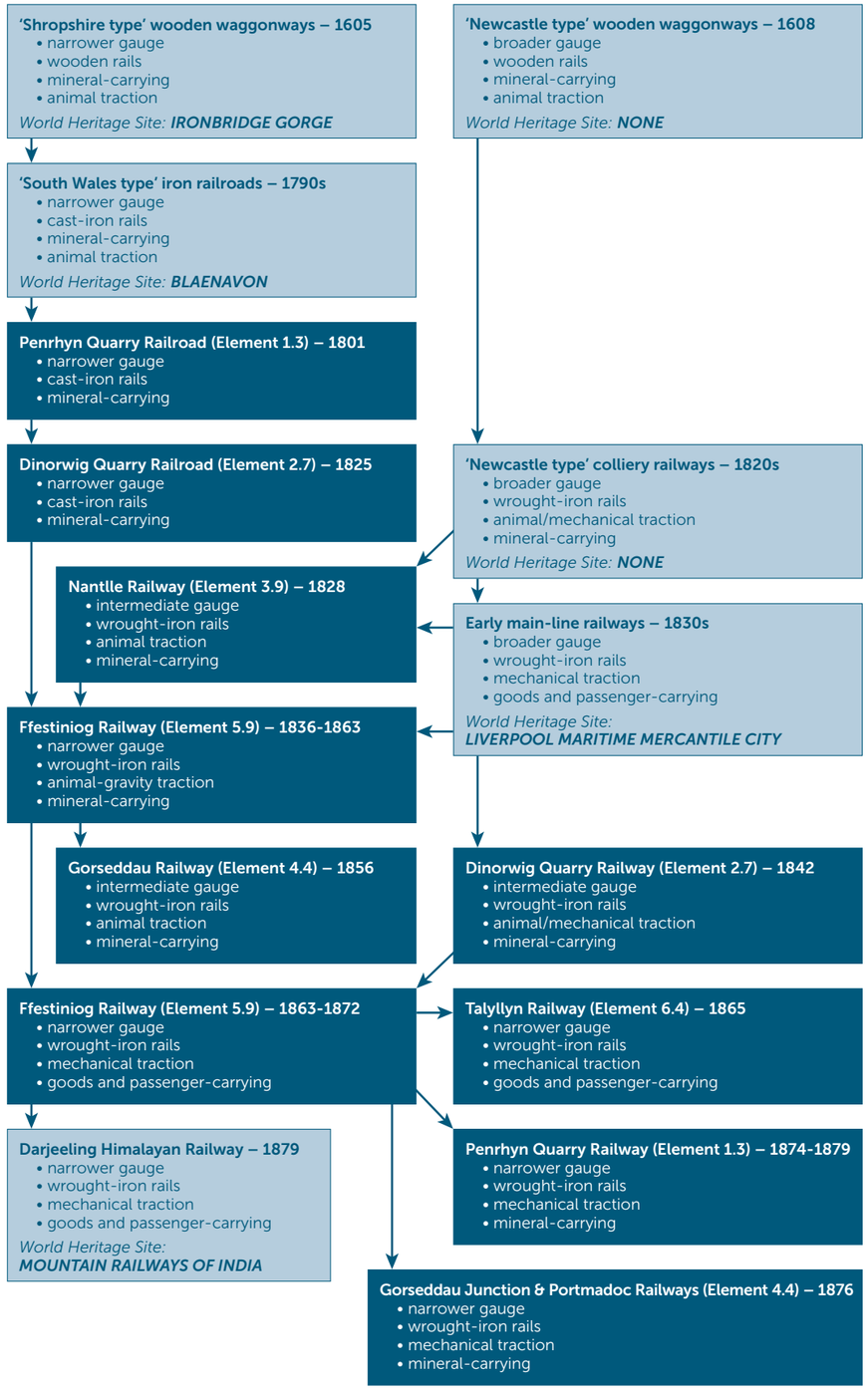


Figure 2.164. Railways in *The Slate Landscape of Northwest Wales* – typological evolution and technology transfer.

Figure 2.165. A short length of the Nantlle Railway (Element 3.9) continued operating, with little change, until 1963. Here 'Prince' and 'Corwen' pull slate wagons from Pen yr Orsedd Slate Quarry (Element 3.8). Primitive though the system then appeared, when it opened in 1828 it represented the state of the art, reflecting advice from the Stephenson family of railway engineers.

This technology was used for the Dinorwig Slate Quarry Railroad (Element 2.7) of 1825, whereas the Nantlle Railway (Element 3.9), completed three years later, made use of the new technology of wrought-iron track on stone sleeper blocks on a broader gauge, on the advice of the famous Stephenson family, shortly before they designed the innovative *Rocket* locomotive for the Liverpool & Manchester Railway.

The most significant of the slate-carrying railways of North Wales is the Ffestiniog (Element 5.9), opened for horse-and-gravity operation in 1836. Robert Stephenson (1803-1859) advised on its construction. It combined the track technology of the Nantlle (Element 3.9) with the Penrhyn (Element 1.3) gauge of 0.6 metres in order to operate its slate trains by gravity along a sinuous course that responded to the challenging terrain of Snowdonia. Its technical success established a model that was adopted worldwide.

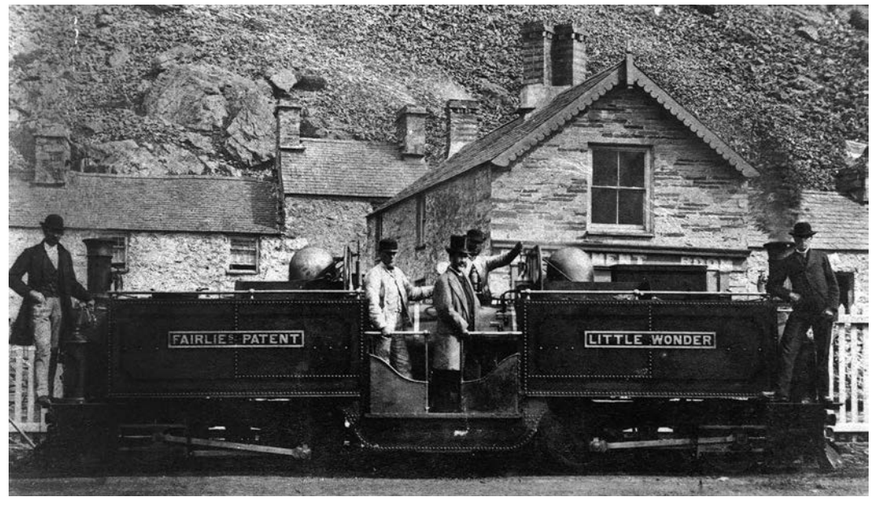


Figure 2.166. The construction and operation of railways to serve *The Slate Landscape of Northwest Wales* required new skills. Here Charles Easton Spooner (in top hat) stands on the footplate of the first of the Ffestiniog Railway's distinctive double Fairlie locomotives *Little Wonder* with crew-members. His son, George Percy, in bowler hat on the running-board to the right, became Assistant District Engineer and Locomotive Superintendent on the Indian State Railway.

***L'example le plus remarquable qui existe des chemins de fer à voie étroite est peut-être celui de Festiniog à Port-Madoc* (The most remarkable existing example of a narrow-gauge railway is perhaps the one from Ffestiniog to Porthmadog (*M. Sevène, Directeur de la Construction de la Compagnie d'Orléans*). (Vignes 1878, 26).**

During the slate boom the Ffestiniog Railway adopted locomotive traction and introduced passenger services to become a small but high-capacity public railway. In 1870, its engineer Charles Easton Spooner (1818-1889) hosted a visit from an Imperial Russian Commission accompanied by guests drawn from the political, technical and financial elites of Russia, Poland, Hungary, India, Mexico, Prussia and France. This focused attention on the possibilities Welsh slate railway technology offered governments and private investors anxious to exploit remote areas and colonial possessions, and armies needing logistical support for static battlefronts. The Ffestiniog Railway strongly influenced later developments.

Spooner's influence is clear in two other railways serving *The Slate Landscape of Northwest Wales*, the Talyllyn Railway (Element 6.4) and the Penrhyn Slate Quarry Railway (Element 1.3) in the use of narrow-gauge, steam traction and a tight formation.

The Talyllyn Railway, completed in 1866, was designed from the outset for locomotive haulage and to carry passengers and general goods as well as slate from Bryneglwys Slate Quarry (Element 6.1). It formed a significant part of the investment in the slate industry made by the Lancashire cotton-mill owners, the McConnel brothers, along with the Quarry itself and the workers' village of Abergynolwyn (Element 6.3). The engineer was James Swinton Spooner (1816-1884), brother of Charles Easton. The railway made history again in 1951, as the first to be taken over by enthusiasts as a heritage attraction. Like the Ffestiniog Railway, it operates its original locomotives and passenger carriages, as well as some of its historic slate wagons – additional associative attributes that help in the understanding of Outstanding Universal Value.

Figure 2.167. Though in no sense the first steam narrow gauge public railway, the Talyllyn (Element 6.4) was very early in combining from its conception the principle of a minimal gauge railway with passenger carriage and locomotive operation as developed on the Ffestiniog Railway.

Charles Easton Spooner influenced the design of the Penrhyn Quarry Railway (Element 1.3), completed in 1879, the steam-worked successor to the Railroad of 1801. This followed a steep and sinuous course avoiding the inclined planes required on the earlier route.

Other, relict, slate railways exemplify different ways of overcoming the challenging terrain of Northwest Wales and using it to advantage. Inclined planes from the quarries are spectacular features which make ingenious use of topography to move output at minimal cost. The Gorseddau Junction & Portmadoc Railways (Element 4.4), completed in 1875, includes a lightly engineered section with minimal earthworks to the Prince of Wales Slate Quarry, as well as making use of a well-built formation to Gorseddau Slate Quarry (Element 4.1) constructed twenty years earlier by James Brunlees (1816-1892), a distinguished engineer with an international profile.

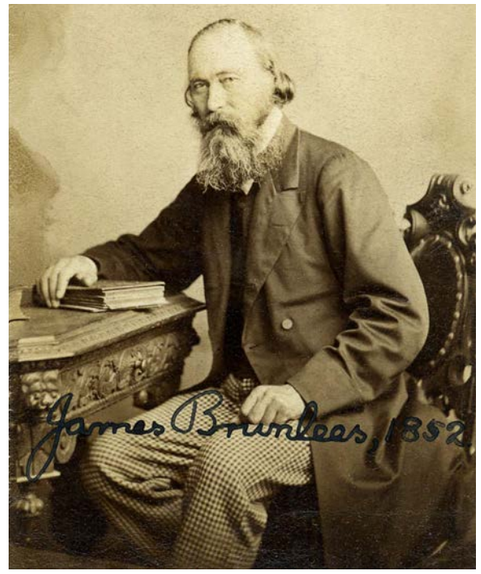


Figure 2.168. Sir James Brunlees (1816-1892) was one of a number of celebrated engineers who came to be involved in the slate industry of Wales. After building the Gorseddau Railway (Element 4.4), he became the Engineer of the São Paulo Railway in Brazil (see UNESCO tentative list, *Cultural Landscape of Paranapiacaba: Village and railway systems in the Serra do Mar Mountain Range, São Paulo, Brazil*) and of the Mersey Railway, and director of the Mt Cenis Pass Railway, as well being involved in other railway projects in England, Ireland and New Zealand and the Channel Tunnel scheme of 1872.

Ffestiniog Railway practice influenced other narrow-gauge railways across the globe. Spooner's more extravagant claims were soon disproved, but it emerged as an effective model for military, agricultural and industrial transport, as well as in desert or mountainous terrain in European colonies. An offshoot is the Darjeeling Himalayan Railway in West Bengal, part of the World Heritage *Mountain Railways of India* since 1999. The Darjeeling's assistant engineer was Thomas John Spooner (1862-1937), nephew of Charles Easton Spooner.

Longer 0.6 metre gauge systems, totalling between them many thousands of kilometres, ran in France, Hungary, Pomerania, the Union of South Africa and German South West Africa, Venezuela, New Guinea, the Belgian Congo and above all in Morocco. Temporary systems on the same principle performed a vital role for which they were ideally suited, and on a huge scale in the First World War, supplying the trenches with ammunition, shells and troops, and removing the wounded.

Figure 2.169. Although the Ffestiniog Railway (Element 5.9) closed in 1946 as the slate trade declined, it was re-opened in stages as a heritage railway from 1955 to 1982. It operates several of its first locomotives from the 1860s as well as many of its original mid-Victorian passenger carriages. It has recently restored to working order its fleet of slate wagons for demonstration purposes, a fascinating asset which adds to the interpretation and presentation of the Nominated Property.

Figure 2.170. The Ffestiniog-inspired Darjeeling Himalayan Railway has been a World Heritage site since 1999. Its distinctive B class locomotives are contemporary with the locomotives built for the Penrhyn Slate Quarry Railway. Small but powerful, they proved ideal for working sharp curves and steep gradients such as here at 'Agony Point'.

2.b.viii An Industrial Revolution

Transformation through capital investment

The Component Parts of the Nominated Property represent the diverse social groups which owned, or invested money and skill in, this classic landscape of the Industrial Revolution. These varied from hugely wealthy landowners with seats in Parliament, through bankers and entrepreneurs, locally based partnerships and 'penny capitalists', to quarrymen in the black economy who owned no more than their hand-tools. Between them they created *The Slate Landscape of Northwest Wales*.

The two biggest slate quarries, Penrhyn (Element 1.1) and Dinorwig (Element 2.1), were operated directly by their aristocratic owners as a part of their estates (Element 1.7). This was uncommon in the British industrial revolution, where patricians preferred to lease out their mineral rights to entrepreneurs.

In 1782, Richard Pennant, Lord Penrhyn, began to re-invest the extensive profits from his Jamaican sugar estates in the slate veins on the eastern slopes of the Bronllwyd Mountain in the Ogwen Valley, uniting the different workings into one quarry (Element 1.1). Pennant developed his quarry and farms as an 'improving landlord' on the same principles as he managed his West Indian properties, where he closely controlled the lives of his slaves and other dependants.

Figure 2.171. Richard Pennant, Lord Penrhyn, indicates on a map his new road system through the Ogwen valley. In May 1788, he was one of 'only two Members *(of Parliament)* who ventured to speak in extenuation if not in justification of the African *(slave)* trade. Henceforth he spoke frequently in defence of the slave trade "denying the facts advanced, appealing to the prudence and policy of the House *(of Commons)* against their compassion"'.

In 1820 Thomas Assheton Smith I (1752-1828), lord of the manor of Dinorwig, assumed the management of the slate workings on his estate. He owned lands in Cheshire and Hampshire, and sat in the House of Commons. He and his heirs ran Dinorwig Slate Quarry until it closed in 1969.

Previously these two quarries had been operated by local common-law partnerships, a system which survived as the 'bargain'. Such partnerships were initially composed of working men and their families; as profits grew, lawyers, bankers and entrepreneurs also became involved.

William Oakeley (1750-1811) of Plas Tan y Bwlch (Element 5.7) was the principal landowner in the Ffestiniog Component Part 5. An 'improver' like Lord Penrhyn, he left his mark on the landscape around his house and gardens at Plas Tan y Bwlch, but leased out his slate quarries. The political career of the British statesman Lord Palmerston (Prime Minister from 1855 to 1858 and from 1859 to 1865) was supported by the profits from his tenancy of one of these quarries. The Greaves banking family from the English West Midlands developed Llechwedd Slate Quarry in Ffestiniog, and their descendants retain ownership. In Nantlle, local Welshmen developed, and retained control of, Dorothea Slate Quarry (Element 3.3).

The Joint Stock Companies Act of 1856, by which any group of seven people or more could register a limited liability company for themselves, coincided with the start of the great slate boom. The Companies Act of 1862 allowed any seven or more associates to constitute themselves as a company with limited or unlimited liability, and was widely adopted in *The Slate Landscape of Northwest Wales*. In 1863, one British company in every nine registered with the Board of Trade in London

Figure 2.172. ' ... one of the earliest sculptured proletarians ... the peasant girl near him is, perhaps semi-allegorically, rather décolletée' (Hobsbawm 1999, 135). Richard Westmacott's 1820 memorial to Richard Pennant, first Lord Penrhyn, in Llandygái church depicts a quarryman wearing a classical tunic, holding a crow-bar and clutching a slate-trimming knife. The statues symbolise Lord Penrhyn's investment as an improving landlord in both quarrying and farming.

Figure 2.173. Richard Pennant invested in technology. In 1796 his agents installed a Boulton and Watt steam engine fired on sugar-cane on his sugar estate at Denbigh in Jamaica, but water-power operated machinery at Penrhyn Slate Quarry (Element 1.2).

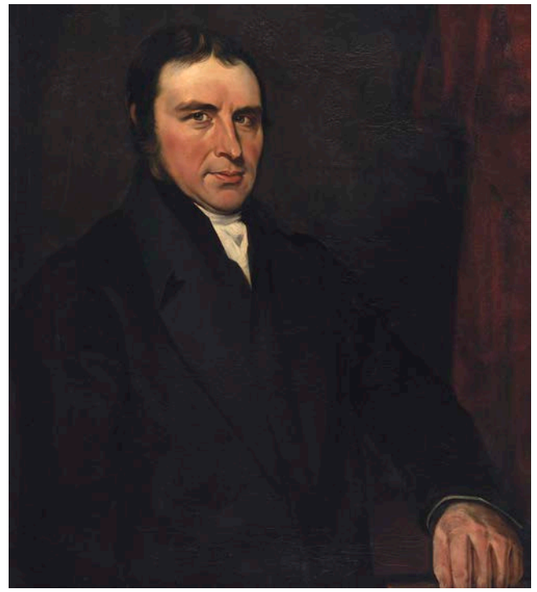


Figure 2.174. The Reverend John Jones Talysarn (1796-1857) represents the Welsh face of managers and investors in *The Slate Landscape of Northwest Wales*. A quarryman and a labourer with no formal education, he was ordained into the Methodist ministry, and became famous as an eloquent preacher. He was a reluctant manager of Dorothea Slate Quarry (Element 3.3) in Nantlle from 1850, as he disliked putting his neighbours and members of his congregation out of work when times were hard.

was concerned with the quarrying, processing or marketing of slate. William McConnel of Manchester formed the Aberdovey Slate Company Limited in 1864 to work Bryneglwys Slate Quarry (Element 6.1). Gorseddau and Prince of Wales slate quarries (Elements 4.1-2) also reflect this commercial optimism.

Quarrymen invested their accumulated knowledge of the rock in their work, as well as their health, in a dangerous industry. The shelters where they gathered for lunch and for discussion, or which they built on tips of waste rock to split slates when times were hard, have no architectural ambition, but exemplify their social identity and cultural confidence, as well as their skill and resourcefulness.

Transformation through mechanised solutions

The high levels of capital investment in *The Slate Landscape of Northwest Wales* made possible a partial transition from craft-skill to machine-based operation, a characteristic of the Industrial Revolution. Not only does the technology-transfer

already described demonstrate the interchange of knowledge and ideas, but the adoption of mechanised solutions also made possible the industrial transformation of this mountain landscape, on a monumental scale. The use of railways, inclined planes and water-power created the distinctive landforms of the quarries, with their level stepped galleries and working areas. The long, low slate mills indicate the scale of processing necessary to turn this natural resource into a commercial product. Throughout, the individual, human scale also remains evident, in the smaller buildings and spaces the quarrymen created for themselves, and in the scale of endeavour it took to create the rock-faces and the enormous waste tips.

Figure 2.175. Ancoats mill in Manchester (England) formed part of the largest cotton-spinning business in the United Kingdom. Its owner, William McConnel (1809-1902), reinvested his capital in *The Slate Landscape of Northwest Wales*, in Bryneglwys quarry (Elements 6.1-2), building the village of Abergynolwyn to house quarrymen and their families (Element 6.3) and the Talyllyn Railway to transport slate (Element 6.4). Courtesy: Centre for Applied Archaeology, University of Salford: 4428.

Transformation through exploitation of natural resources

A striking attribute of the quarries themselves is that, although they represent a dramatic level of intervention in the natural environment, their scale, form and organisation also clearly demonstrate how natural resources were ingeniously used to develop them. Quarrying had to follow the rock, and was dictated by the geology it exposed. The use of hillside slopes to construct counterbalance (self-acting) inclined planes is evident in every Component Part, as is the harnessing of the region's abundant rainfall as water-power to operate machinery. The Penrhyn (Element 1.3), Dinorwig (Element 2.7), Gorseddau (Element 4.4) and Ffestiniog (Element 5.9) railways all make skilful use of topography to provide appropriate gradients to assist the movement of the load, and to balance cuttings with causeways and embankments. The shape and form of ports, quays and harbours (Elements 1.4, 5.8, 5.10) exploit the shifting currents of the region's rivers, estuaries and sea-coast.

2.b.ix New forms of social organisation

Housing an expanding workforce

The expansion of quarrying created an urgent need to house the expanding workforce. New and varied forms of human settlement both introduced and reflected new forms of social organisation. The Component Parts of the Nominated Property have been chosen to include the entire range of settlement associated with the industry. All were created from new between the late eighteenth and mid nineteenth centuries, and were often carved out of inhospitable upland tracts.

Before 1780

Before the expansionist period from 1780, there was no need to build special accommodation for slate quarrymen. Specialist slate workers were few, and merged into the broader agricultural community.

Barracks

The sudden social dislocations generated by industrialisation frequently created a need for barrack accommodation, which became a distinguishing feature of the industry during the boom of the 1860s and 1870s and for many years thereafter. Examples at Dinorwig (Element 2.3) have been conserved and Nantlle (Element 3.10) have been brought back into use as a community centre. They are unlike barracks associated with other extractive industries elsewhere in the world, or the 'compounds' in African diamond mines, as they were typically built as long cottage rows, and some housed entire families.

'The barrack system is also found in Great Britain, especially in North Wales, but not on so large or so sumptuous a scale as in Germany. In Wales men often sleep two to a bed upon straw mattresses ....' (Foster and Cox 1910, 712).

Figure 2.176. The interior of a Ffestiniog barracks in 1901. Papers cut from the illustrated papers showing the war in South Africa are peeling off the walls in the humid conditions.

Smallholdings

Smallholdings on uplands previously considered unsuitable for cultivation were a characteristic form of settlement within the industry. Some were created by industrialists and landlords, others represent unregulated squatter occupation. Treforys (Element 4.5) is a relict settlement built by the entrepreneurs who leased

Figure 2.177. The slopes of Cilgwyn Mountain belonged to the Crown. Quarry families began to build cottages and enclose plots of land here, without legal sanction, from 1800 onwards (Element 3.11).

Gorseddau Slate Quarry, who were perhaps inspired by contemporary theories about housing rural populations in Highland Scotland and Ireland. It is located on a bleak, boggy and windswept hillside around the 305 metre contour where even oats and potatoes will barely grow. Many Penrhyn quarrymen were settled in a similar way on Mynydd Llandygai (Element 1.7), where the estate built uniform houses for them and allotted long garden plots of uniform size. Dinorwig quarrymen were granted parcels of land once the quarry-owning family had secured an enclosure act over the mountain commons, and were entrusted to build their own homes. In Nantlle, the upper slopes of Cilgwyn Mountain were colonised by quarrymen and their families without any legal authority, who then proceeded to build simple vernacular dwellings on them (Element 3.11). Often the women would look after the smallholdings whilst the men worked in the quarries.

Company villages

Company villages in *The Slate Landscape of Northwest Wales* were small and ad-hoc, showing little evidence of the Utopian ambition and lavish philanthropic paternalism exemplified by World Heritage sites such as *New Lanark*, *Saltaire* or *Crespi d'Adda*, but still endeavouring to maintain some degree of control over the workforce. As such, they are more typical of the settlements established by capitalists and entrepreneurs for industrial workers throughout the world; Tan y Grisiau, an extension of the town of Blaenau Ffestiniog (Element 5.6) clings to a hillside and follows the course of the railway (Element 5.9), Abergynolwyn (Element 6.3) is set out in a Lancashire idiom on the floor of the Fathew Valley by its Manchester cotton-mill developers. In the village of Nantlle (Element 3.10), some aesthetic ambition is evident in the minimal ornamentation of the houses.

The pioneer industrial archaeologist, writer and conservationist Tom Rolt loved the Talyllyn Railway (Element 6.4), found the Bryneglwys Slate Quarry (Elements 6.1-2) eerie, and considered the houses in the quarry village of Abergynolwyn (Element 6.3) '... as dark, as dour and as incapable of concession to their surroundings as those which were terracing the valleys of the Rhondda and the Ebbw ... It looks as though a section has been arbitrarily chopped out of a mean street in an industrial city and transplanted in the abortive hope that it might take root and grow.' (Rolt 1971).

Figure 2.178. Pioneering conservationist Tom Rolt in his Alvis car in Bryneglwys Slate Quarry.

Nucleated villages and towns

The slate industry of Wales brought into being completely new industrial towns and villages which form classic Industrial-era settlements, interpreting a basic Georgian urban vernacular to house a burgeoning population. Bethesda (Element 1.6), in the Ogwen Valley, was constructed from the 1820s by quarry families who chose not to live on the Penrhyn estate. The settlement follows Thomas Telford's post road, constructed between 1817 and 1825. The villages of Deiniolen and Clwt y Bont (Element 2.8) were similarly built on a freehold by quarrymen who chose not to accept the largesse of the owner of Dinorwig Slate Quarry. Blaenau Ffestiniog (Element 5.6) was established on a natural shelf where slate-quarry roads intersected; here, earlier ribbon development gave way to planned urban squares and ambitious chapels from the 1870s.

The architecture of chapels in the quarry communities reflects the growing confidence and wealth of their congregations in the nineteenth century. Constant rebuilding and enlargement has meant that few structures survive from before the 1860s, when the ornate gable front becomes common, and economic contraction has meant that very few were built in the twentieth century. The Anglican communion responded to the challenge of Nonconformity by making sure that it was also represented in the new quarry communities.

Figure 2.179. Blaenau Ffestiniog (Element 5.6) in the 1870s. A planned townscape is coming into being, complete with schools and chapels, within an earlier rural environment.

Figure 2.180. The contrast in architectural style between church and chapel, and the rivalry between them, is demonstrated by Henry Kennedy's Christ Church of 1857 and Richard Owen's Methodist Capel y Waun of 1868 near Deiniolen (Element 2.8).

Quarry owners' houses and parklands

The scale of the two quarry owners' houses and estates within the Nominated Property, Penrhyn Castle and Park (Element 1.7) and Plas Tan y Bwlch (Element 5.7), illustrate the level of profits that could be reinvested in, and made from, *The Slate Landscape of Northwest Wales* by wealthy aristocrats. On a smaller scale, Plas Tal y Sarn (Element 3.12) and its gardens illustrates the proximity of extractive sites to the dwelling of one of the industry's middle-class investors. These offer a marked contrast to the homes of those who worked in the industry.

Figure 2.181. The scale of the parklands associated with Penrhyn Castle is apparent in this aerial view.

A money economy

Growing prosperity in *The Slate Landscape of Northwest Wales* created a consumer society, evident in the shops and department stores of Bethesda (Element 1.6) and Blaenau Ffestiniog (Element 5.6), where the market hall was built between 1861 and 1864, subsequently extended in 1883.

Figure 2.182. Blaenau Ffestiniog's market hall (Element 5.6) not only exemplifies the arrival of consumer choice to working class communities in the 1860s but also demonstrates the growing cultural confidence of the quarrymen and their families, as it was used for theatrical performances and political meetings. It was here that David Lloyd George (1863-1945; British Prime Minster, war-leader and statesman) was told that he must stand for parliament. It was served by a siding from the Ffestiniog Railway (Element 5.9).

Healthcare and hospitals

Medical care for specialist workers in a hazardous working environment has been a feature of extractive industries since the medieval period. The three hospitals for quarrymen in *The Slate Landscape of Northwest Wales* were each established by the principal local landowner – each one prominently sited on the way to the quarry so the benign intent was clear to visitors. The Penrhyn estate, with its long experience of managing enslaved workers' health and fertility on its plantations in Jamaica, showed the way in 1840–42 (Element 1.1). The Ffestiniog Hospital followed in 1848 (Element 5.6), and Dinorwig Quarry Hospital (Element 2.10) in the 1860s. All follow the same pattern of a central reception block with projecting wings for the wards. The Dinorwig Slate Quarry Hospital (Element 2.10) is now a museum open to the public, displaying its innovative equipment, including amputation tools and an early X-ray machine. It exemplifies both patrician philanthropy and the increasing professionalization of medical treatment, since it was established to control health provision and to dispense with the services of traditional bone-setters, whose skills in the therapeutic movement of skeletal joints had been central to the distinctive medical history of Northwest Wales.

Figure 2.183. Company hospitals and clinics for workmen and their families were never common in Britain but were more often found in continental Europe. The San Rafael Mining Hospital (World Heritage Site: *Heritage of Mercury: Almadén and Idrija*) in Almadén (Spain) was built in 1755, and provided care for miners for over two hundred years.

Health and safety in *The Slate Landscape of Northwest Wales*

The slate quarryman's occupation was not a healthy one. Dedicated hospitals (Element 2.10) provided treatment for accidents but medical opinion was slow to recognise and address the respiratory impact of slate dust generated by powered drilling at the rock-face or by circular saws in the mills. Struggles for fair employment practices and just wages within the quarries led to the foundation of the North Wales Quarrymen's Union in 1874 – later absorbed into the Transport and General Workers' Union. It was these unions which led a long campaign from the 1940s through to the 1970s to secure state-funded compensation for quarrymen who suffered from lung-diseases arising from their employment. This culminated in the enactment of the Pneumoconiosis, etc (Workers' Compensation) Act 1979, which led to compensation being paid not only to ex-quarrymen and their widows, but also to workers in other industries who suffered from industrial lung diseases and who could not gain redress from employers who had gone out of business. In this, as in many other aspects, the slate-quarrymen of Northwest Wales led the fight for social justice, from which many other working people, in other areas and industries in the United Kingdom, eventually benefitted.

Figure 2.184. The Dinorwig Slate Quarry Hospital (Element 2.10). Dr Robert Herbert Mills Roberts (1862-1935) presided over the Hospital from 1890 to 1914. A pioneering and dedicated surgeon, he came from a famous local dynasty of bone-setters which provided a surgeon to the Royal Navy as well as doctors to all three quarry hospitals. He graduated from University College, Aberystwyth and St Thomas's Hospital, London. His experience of traumatic injury was invaluable during the Boer War, when he established the Welsh hospital in the Transvaal, and as a senior officer in the Royal Army Medical Corps in World War One. He considered quarrymen's health to be their own responsibility, and urged them to keep their houses and their clothes clean, to avoid drinking stewed tea and to eat a varied diet.

Figure 2.185. The Bethesda Women's Choir.

Women and the slate industry of Northwest Wales

Women took little active part in the industry itself. In the eighteenth century they sometimes ran small quarries and were often responsible for pack-horses and carts carrying the slates to navigable water, but in an increasingly masculine environment, their main option was to marry young and to produce a large family. Locations like the Pen y Bryn barracks (Element 3.5) exemplify the teeming, crowded conditions where young mothers had to clean, cook and look after small children and growing families as well as tend garden-plots, whilst the men worked nearby in the quarry. The novels and short stories of Kate Roberts (1891-1985) celebrate the hard-working, frugal life of women in these part-industrial, part-rural areas, and acknowledge the plight of those who could not live by its rules.

When times were good, quarrymen's wives were sometimes criticised for their showy outfits and lavish front parlours. Prosperity could rarely be taken for granted; family circumstances might change drastically with a husband's death in the quarry, or a woman's death in childbirth. Second and third marriages were common.

Women were actively involved in the religious life of the slate communities, and in their choral traditions. The Bethesda (Element 1.6) Women's Choir toured Wales and England to raise money for the Penrhyn Quarry (Element 1.1) strike of 1900 to 1903, and performed with male voice choirs to support Belgian refugees in 1914 (*The London Kelt*, 6 July 1901; *Yr Herald Cymraeg*, 1 December 1914).

2.b.x Adapting to modernity, retaining tradition

Transformation

Quarrying, processing and transporting slate in Northwest Wales not only changed architecture and building all over the world but also transformed a rural landscape and a marginal culture into a modern industrial society. This process was at times painful, as old ways of life collided with new, and as different social groups sought to impose their will on these new communities. Several bitter industrial disputes broke out. Each Component Part of *The Slate Landscape of Northwest Wales* illustrates in different ways the social trauma of industrialisation.

Industrialisation did not efface traditional ways of life or a minority language. These continued to shape the way *The Slate Landscape of Northwest Wales* evolved in the period 1780 to 1940, just as in many ways they remain strong to this day.

'The confident culture of Welsh-speaking Wales, with its vigorous community life, its traditions of poetry, music-making and the visual arts, and its respect for learning, reflects how a once slow-moving, traditional minority culture adapted in the classic "Industrial" period and could meet new challenges again. The past tells a story in which confidence and a willingness to learn, to contemplate change and to engage with a new world, emerge as the main themes, more so even than the undoubted realities of sickness, exploitation and fear which came with industrialisation. In the process, Wales transformed, radicalised and strengthened itself, its identity and its language. The slate industry was central to that change.' (Gwyn 2015).

Continuity within a changing landscape

Investment of skills, labour and minimal level of capital by local population

The Slate Landscape of Northwest Wales illustrates an important attribute of industrial society, namely the essential investment of skill, labour, and sometimes also minimal capitalisation, by the people who work in it. Quarrymen, practically all drawn from the immediate rural hinterland, soon developed the intellectual skills necessary to become effective workers, as well as demonstrating much-needed muscle-power. They made themselves responsible for their own tools and their own gunpowder, and firmly believed that the rock in their 'bargain' belonged to them, not to the quarry-owner or investors.

Persistence of low-technology and craft-based processes in quarries

Throughout the major industrial period of quarrying from 1780 to 1940, craft-skills remained crucially important to working slate quarries. Isolated slate-splitters' shelters erected on tips of slate rubble in Cilgwyn and Dorothea slate quarries (Elements 3.1, 3.3) exemplify the least prosperous class, unemployed quarrymen who had only their skills, labour and tools to invest, who earned a precarious living in times of hardship by reworking blocks which had previously been dumped, to produce small roofing slates and damp-courses.

Figure 2.186. Gorseddau Slate Quarry (Element 4.1) lies in the middle distance, at the head of a remote valley where Ordovician rock outcropped on the hillside and attracted the interest of the first speculators here. In the foreground is the Ynysypandy slate-slab mill (Element 4.3), located where a fall of water could operate machinery. The course of the railway to the quarry leads past the abandoned quarry village of Treforys, on the upper left side of the lake (Element 4.5); its branch to Prince of Wales Slate Quarry curves off to the left (Element 4.4). All of these lie within a farming landscape that has evolved since the Bronze Age.

Reinforcing traditional social identity, renewing cultural confidence

The new quarry villages and towns built their own libraries and reading rooms, and a barracks would have a shelf of books, but the quarrymen's rich cultural life was also sustained by an institution they created themselves known as the *caban* ['cabin'] or at Penrhyn Slate Quarry (Element 1.1) as the *cwt tân* ['fireplace hut'], a simple shelter where between 10 and 80 men gathered for their lunch and for a formal discussion, often on political matters, or for recitation, singing, poetry or quizzes. A quarryman who was ill, or who wanted to go on to university or to theological college, would be helped financially by his *caban*. The *caban* was rooted in earlier rural traditions of community life and mutual support, and of story-telling and entertainment.

Figure 2.187. Ifan ab Owen Edwards' film *Y Chwarelwr* ['The Quarryman'] of 1935, made with a largely amateur cast of quarrymen and their families, shows a *caban* meeting in Oakeley Slate Quarry in Ffestiniog (Component Part 5).

Figure 2.188. *Cabanau* survive in many quarries. This one is on Australia Gallery in Dinorwig Slate Quarry (Element 2.2) – even the men's boots remained for many years.

Renewed strength to Welsh language

A marginal culture that becomes incorporated into a global industrial system often loses its distinctive way of life and its minority language. The historic cultural vitality of *The Slate Landscape of Northwest Wales*, by contrast, ensured that it remained strongly Welsh in speech, and is so to this day. Its religious identity was also an important factor.

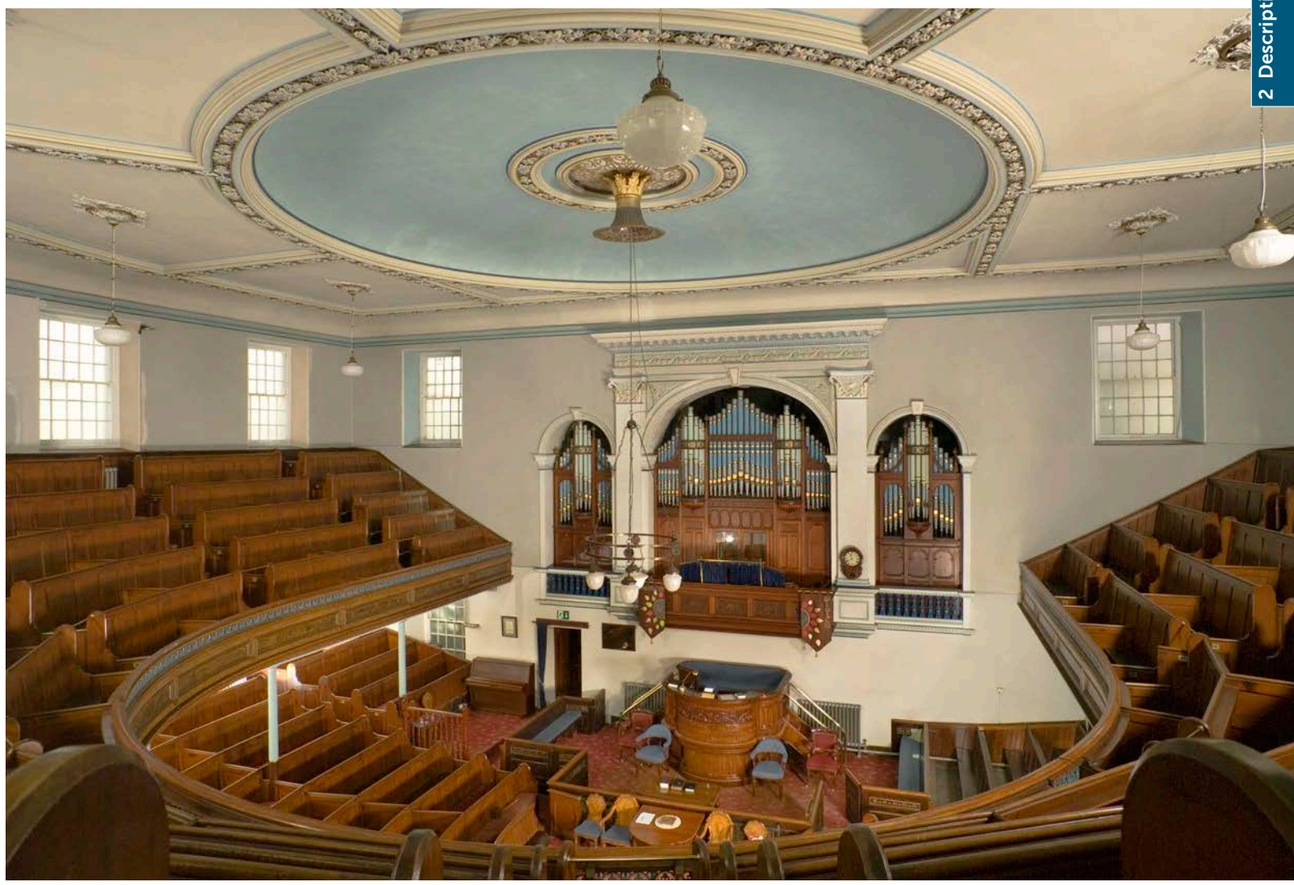


Figure 2.189. Methodism is a religion of the word. The scale and centrality of the pulpit in 'Jerusalem' chapel in Bethesda (Element 1.6) illustrates the importance of the sermon in collective worship. Chapels had their own adjacent schoolrooms for Sunday schools and for community activities such as literary societies.

As quarry communities forsook the Anglican state church for the chapels of Methodism and other forms of Protestant Nonconformity, as Baptists or Independents, church and chapel came to have an uneasy relationship. The church drew its religious authority from tradition and its local influence from powerful land-owning patrons. Chapels offered visionary sermons, a ministry drawn from the people themselves, and the opportunity to organise and express the community's own values. The church identified with Conservatism, the chapels with the Liberal Party, and ultimately with the Labour movement.

Figure 2.190. Places of worship were strategically located in *The Slate Landscape of Northwest Wales*. Bethesda chapel, the nucleus of the future settlement, was built on the edge of a freehold where the London to Holyhead road ran through the Ogwen Valley (Element 1.6) to let the world know that here at least, the quarry-owner had no authority. The land immediately to the right of the chapel (circled) belonged to Lord Penrhyn. The chapel and all the land to its left did not.

The North Wales Quarrymen's Union was founded 1874, slightly later than the Knights of Labor in the USA (1869) but earlier than the Bourse du Travail in France (1887), and reflects the growth and public acceptance of trade unions in industrial countries. Yet the quarrymen also drew on far older traditions of public assembly, holding their Union meetings on a natural outcrop (Element 2.9) at the north-western extremity of Padarn Lake, a traditional gathering-place. Proceedings were opened with the hymn *Arglwydd Dduw Rhagluniaeth* ['Lord God of Providence'].

Most quarrymen were radicals and religious Nonconformists; all spoke Welsh. Their self-identity was reinforced by Welsh-language newspapers, by religious and secular publications, and by *eisteddfodau* – festivals of literature, music, performance and the arts. Wales' National Eisteddfod continues to be held over eight days every August.

The Slate Landscape of Northwest Wales was, and is, a stronghold of the Welsh language, and is home to many people for whom it is a mother-tongue. Slate quarrymen were great readers, and often keen poets and musicians as well.

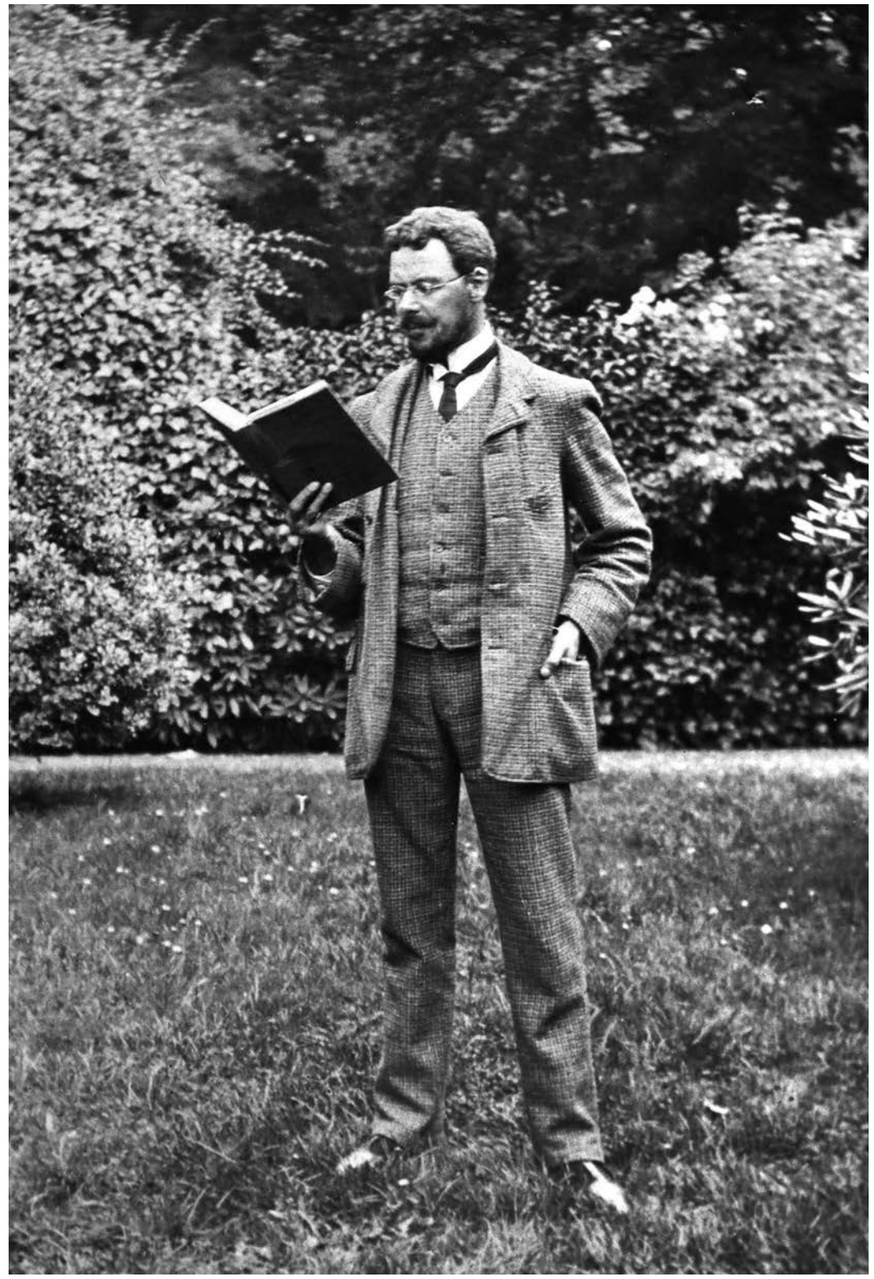


Figure 2.191. Edward Ffoulkes (1850-1917), steward of the Vivian Slate Quarry (Element 2.4), was an authority on the sonnet form in the Welsh language.

Figure 2.192. Bryn Awel (Element 5.6) was built by the tenants of Cwmorthin Slate Quarry in the 1840s as a reading room for their workforce.

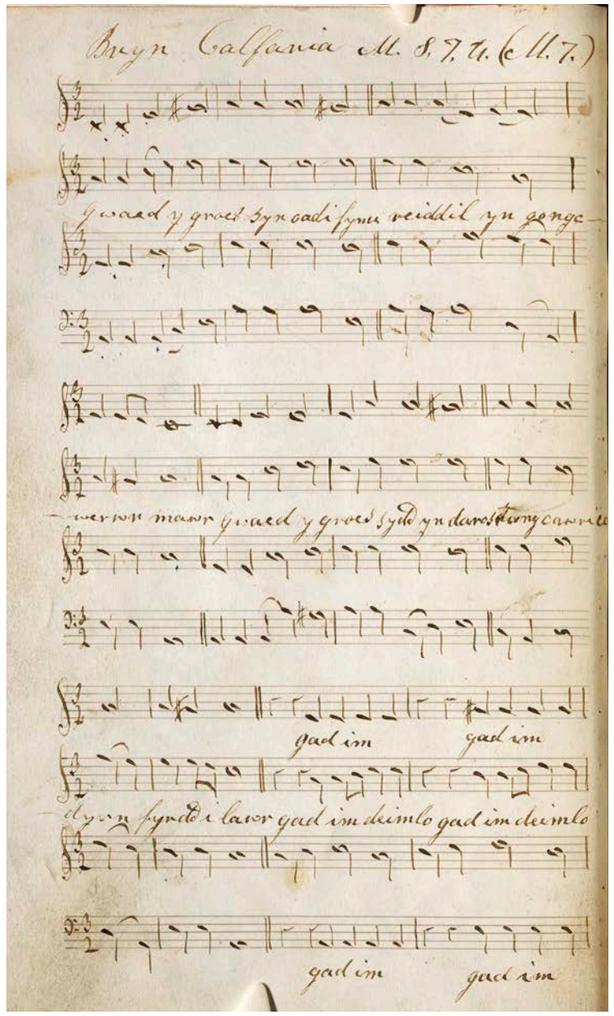

Bryn Calfaria M. 8, 7, 11. (& 11. 7.)
gwaed y groes sydd yn daenu
gwaed y groes
gad im
gad im
dyrys fyrdd i lawr gad im deimlo gad im deimlo
gad im
gad im

Figure 2.193. The quarryman and musician William Owen (1813-1893) is best known for the hymn-tune 'Bryn Calfaria' ['Calvary Hill'], one of the classics of high Calvinism, written in 8, 7, 8, 7, 4, 4, 4, 7, 7 meter, said to have been composed on a slate whilst on his way to work at Dorothea Quarry (Element 3.3) in Nantlle. His melody (shown here in the form of the holograph manuscript) was arranged by Daniel Protheroe of Cwmgiedd and Chicago (USA) as 'Laudamus', and was adapted as a prelude by the well-known English composer Ralph Vaughan Williams.

Social trauma

The Component Parts of the Nominated Property exemplify the social trauma that industrial development brought to a marginal culture, and the ways in which the people of the area responded to change.

The scale of the two quarry owners' houses and parklands within the Nominated Property, Penrhyn Castle and Park (Element 1.7) and Plas Tan y Bwlch (Element 5.7), illustrate the level of profits that could be reinvested in, and made from, *The Slate Landscape of Northwest Wales* by wealthy aristocrats. On a smaller scale, Plas Tal y Sarn (Element 3.12) in the Nantlle Component Part illustrates the proximity of extractive sites to the dwelling of one of the industry's middle-class investors. These contrast with the cottages and terraced rows the quarrymen inhabited (Elements 1.6 and 5.6). In addition, the contrast between rustic cottages on estate-planned settlements and the plainer houses quarrymen built for themselves and their families is particularly evident in the Ogwen Valley and Dinorwig Component Parts (Elements 1.5, 1.6, 2.8). Conflict between Anglicans and Nonconformists meant that churches and chapels were sited for maximum visual impact (Elements 1.5, 1.6, 2.8).

Figure 2.194. At the National Slate Museum (Element 2.5) a row of houses has been re-erected for interpretative purposes, illustrating the way of life of a slate-quarryman and his family in three crucial periods. One is the boom of the 1860s, another during the Penrhyn Slate Quarry strike (1900-1903) – one of the longest disputes in British industrial history – and the third when the Dinorwig Slate Quarry shut in 1969.

The suddenness of industrial change is apparent in the adaptation of earlier buildings as barracks at Pen y Bryn / Cloddfa'r Lôn (Element 3.5), and its often ephemeral nature in Gorseddau and Prince of Wales slate quarries (Elements 4.1-2) and Treforys village (Element 4.5), where the barracks and the cottages were soon abandoned. The contrast in size and social organisation between Blaenau Ffestiniog (Element 5.6) and Abergynolwyn (Element 6.3) illustrate the different forms it took.

At *Craig yr Undeb* ['Union Rock'] (Element 2.9), the natural outcrop at the northwest end of Padarn Lake, social conflict found expression in meetings of the North Wales Quarrymen's Union, founded in 1874.

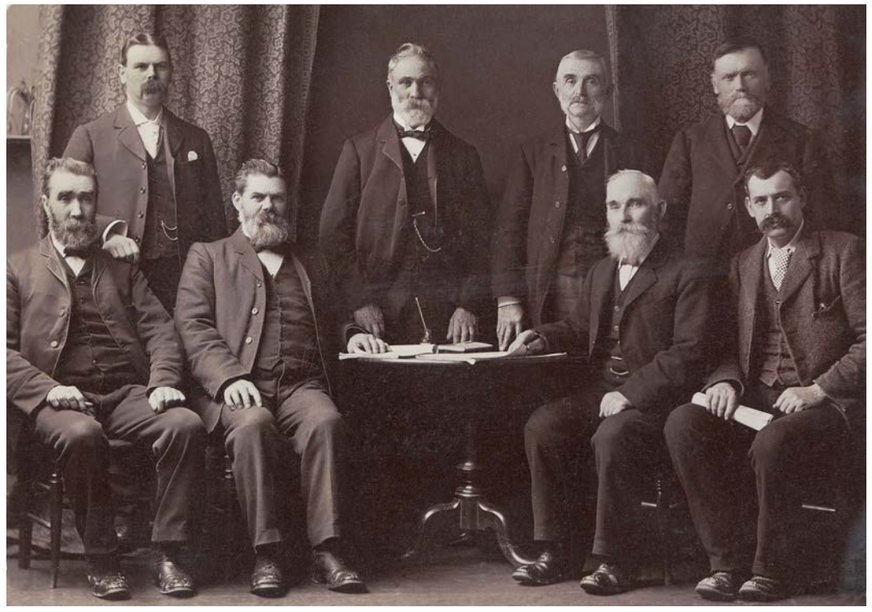


Figure 2.195. Social conflict erupted in a bitter industrial dispute at Penrhyn Slate Quarry (Element 1.1) which went on from 1900 to 1903. The non-revolutionary nature of the quarrymen's leadership is clear in this group photograph of the strike committee.

Pre-industrial landscape – traditional human settlement

Pre-industrial ways of life remain evident within each Component Part, evidence both of time-depth from before the late eighteenth century and also of the distinctive form in which industrial development took place in this marginal region with its strong cultural traditions.

Persistence of rural forms in dwellings and settlements

Northwest Wales forms part of the 'highland' zone of the British Isles. Until the late eighteenth century its economy depended on marginal agriculture – on pastoral farming and transhumance – and on a long tradition of resourcefulness which was inherited by the quarry communities. Few farmers' dwellings from this period survive. Cottages for quarrymen and their families, typically two-room buildings with gable hearths and a half-loft, derive instead from sub-medieval yeoman and gentry dwellings in the region. Variants on this design are found on planned smallholdings including Mynydd Llandygai (Element 1.5) and Treforys (Element 4.5), on squatter settlements at Dinorwig and Fachwen (Element 2.8) and Cilgwyn Mountain (Element 3.11), within quarries as barracks at Dinorwig (Element 2.3), at Pen y Bryn /Cloddfa'r Lôn (Element 3.5), in the village of Abergynolwyn (Element 6.3) and in an urban context in Bethesda (Element 1.6) and Blaenau Ffestiniog (Element 5.6). These illustrate the evolution of a regional style and its rural antecedents, and provide a contrast with the more specifically industrial type of housing which is also to be found in quarry settlements, the two-storey double-fronted dwellings typical of the British Industrial Revolution.

Persistence of rural forms – squatter settlements and field-scapes

'The farmer's calendar was, therefore, to some extent the quarryman's also, and a good number of hands skilled in gauging rock and wielding chisel and mallet could also perform with a long scythe in one of the bands that on July mornings would, standing in line, swathe their way through hilly hay fields. Many quarrymen had relatives who had farms or smallholdings and many lived with parents or other relatives on small plots of land'. (Jones 1981, 19).

Throughout the Nominated Property, pre-industrial and rural building forms are evident. The houses of prosperous tenant-farmers survive in Bethesda (Element 1.6), Nantlle (Element 3.10) and Abergynolwyn village (Element 6.3), where the farm-house became the Red Lion Inn and later the Railway Inn, and at Pen y Bryn / Cloddfa'r Lôn (Element 3.5) where barracks and other quarry buildings grew up in the field system associated with the seventeenth-century gentry house. In both the Nantlle and the Ffestiniog Component Parts, field walls and enclosures from before the main period of quarrying are evident, their pattern often broken by the expansion of quarry workings. The cottage-plots at Dinorwig and Fachwen (Element 2.8) and on Cilgwyn Mountain (Element 3.11) reflect a well-established Welsh tendency to dispersed settlement on poor land.

Figure 2.196. Most of the boys in this school-group of 1903 would have followed their fathers into the quarries and most of the girls would have married young. The tall girl in the middle of the second row from the back is Kate Roberts, daughter of a Cilgwyn (Element 3.1) quarryman, who went on to gain her degree from what is now Bangor University before becoming a teacher, a publisher, and an acclaimed Welsh-language novelist and short-story writer.

Growing up in *The Slate Landscape of Northwest Wales*

For many years, a quarryman's son would join him at work as soon as he was old enough. Girls would care for smaller children in order to be prepared for marriage and raising a family. Increased educational opportunities towards the end of the nineteenth century encouraged children to seek a better life. Passing the 'scholarship' to secondary education was an important step towards securing a place at university.

The first Welsh-language 'talkie', *Y Chwarelwr* ['The Quarryman' – 1935] filmed in Blaenau Ffestiniog (Element 5.6) dramatises the hard choices children often had to make. It shows how a promising boy leaves school for the quarry after his father's death to allow his more academically able younger sister to complete her education. Caradog Prichard's novel *Un Nos Ola Leuad* ['One Moonlit Night' – 1961] is more traumatic still; a narrator living in the quarry town of Bethesda (Element 1.6) who may be a child or a man remembering his childhood, faces his mother's descent into insanity.

2.b.xi *The Slate Landscape of Northwest Wales* today

The Slate Landscape of Northwest Wales has seen remarkably little change since the early twentieth century and survives with remarkable integrity. As a marginal area within the United Kingdom economy, Gwynedd has experienced few development pressures, and the region as a whole has adapted very well to an economy based on tourism rather than agriculture or mineral extraction.

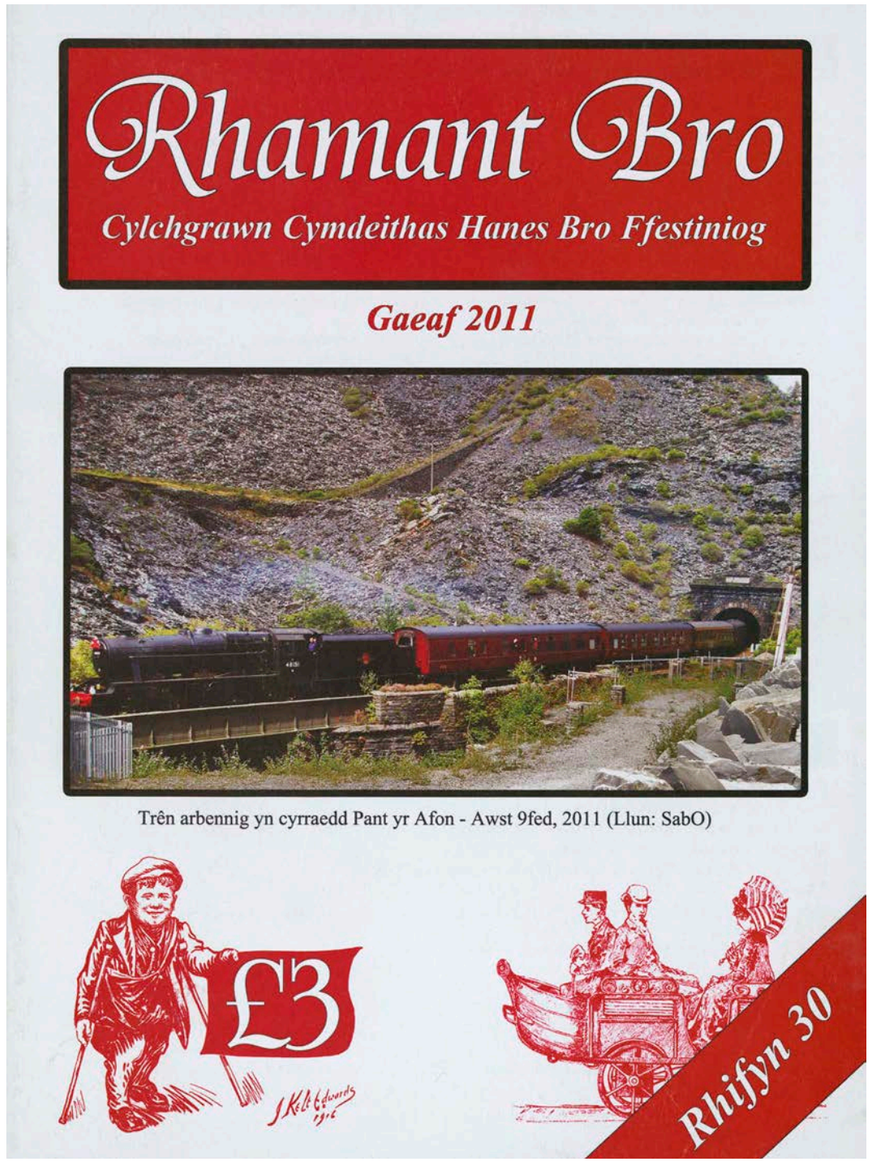

Rhamant Bro
Cylchgrawn Cymdeithas Hanes Bro Ffestiniog
Gaeaf 2011
Trên arbennig yn cyrraedd Pant yr Afon - Awst 9fed, 2011 (Llun: SabO)
£3
Rhifyn 30

Figure 2.197. The town of Blaenau Ffestiniog (Element 5.6) publishes its own annual Welsh-language scholarly journal of local history. *Rhamant Bro* reflects a long tradition of historical writing within *The Slate Landscape of Northwest Wales* dating to the late eighteenth century.

Following in the footsteps of Prince Pückler-Muskau (see overleaf) and the aristocratic visitors of the late eighteenth and nineteenth centuries but on a more inclusive basis, tourism is now an important part of the slate economy. Elements within the Nominated Property have become major tourist attractions in their own right. These are set out in Section 4**,** but in summary, this begins with the Talyllyn Railway (Element 6.4), preserved by enthusiasts in 1951, after the export of slate from Bryneglwys Slate Quarry (Elements 6.1-2) came to an end. This was the first railway in the world to be taken over and successfully operated by a volunteer organisation. The Ffestiniog Railway (Element 5.9) was revived after a period of closure, and after many years' endeavour was re-opened to its original terminus in the slate town of Blaenau Ffestiniog (Element 5.6) in 1982. Both now enjoy an international reputation. Penrhyn Castle and Park (Element 1.7) are open to the public, and Plas Tan y Bwlch (Element 5.7) is a residential study centre managed by the Snowdonia National Park which offers courses on the history and archaeology of the quarries, settlements and transport systems. The National Slate Museum opened in the former Dinorwig Slate Quarry Engineering Complex (Element 2.5) in 1972.

Heritage-compatible adventure tourism is well-established in several locations. At Penrhyn (Element 1.1) and Llechwedd (Element 5.1) quarries, overhead zip-wires recall the ropeway handling systems which once spanned these workings and enable visitors to appreciate the quarry landform in new and exciting ways. Llechwedd and Cwmorthin (Element 5.2) both offer underground historical tours and adventure experiences.

Within the region, the modern-day slate economy is valued as a major contributor to prosperity and cultural identity. The slate industry continues to play a significant part in the present-day strength of the Welsh language in Gwynedd. Despite decline in the twentieth century, the number of Welsh speakers is now stable. In 2011, 19% (562,000) of residents of Wales aged three and over were able to speak Welsh, and 77% of these were able to read and write the language (15% of the total population). It is the only Celtic language not classified as 'endangered' by UNESCO. Its heartlands lie in Gwynedd, and within Gwynedd in *The Slate Landscape of Northwest Wales*. Bangor University, to which quarrymen and chapel congregations contributed generously from their meagre resources, remains at the heart of its traditional community, and schools have embraced their industrial heritage. New forms of music-making, literature, social media and publication reflect a confident, welcoming and outward-looking Welsh-speaking community which understands and values its roots in the slate industry. The landscape also provides a challenging and dramatic backdrop to outdoor events such as triathlons and marathons in addition to cultural and musical experiences.

Industrial tourism

A Saxon nobleman visits Penrhyn Quarry

Tourism has been a feature of *The Slate Landscape of Northwest Wales* since the late eighteenth century and is now an important contributor to the slate economy.

Early tourists were drawn from the ranks of the European wealthy, with the leisure and resources to travel. Many sought out the Picturesque landscapes of the region but also found themselves intrigued by the Sublime environments of the quarries themselves. One such was the Saxon Prince Hermann Ludwig Heinrich von Pückler-Muskau, creator of the Muskauer Park / Park Mużakowski on the Neisse river, now a World Heritage Site. He was one of many who left an account of their visits.

'I followed a very romantic road, which led me through the park, and then along the bank of a beautifully wooded mountain stream, and in about an hour arrived at the slate quarry, which lies in the midst of the mountains, six miles from the castle. From what I have already told you, you may imagine what a vast work this is. Five or six high terraces of great extent rise one above another on the side of the mountain; along these swarm men, machines, trains of a hundred wagons attached together and rolling rapidly along the iron rail ways, cranes drawing up heavy loads, water courses, &c. ... I was obliged to lie down in one of the little iron wagons which serve for the conveyance of the slate, and are drawn by means of a windlass through a gallery hewn in the solid rock, only four feet in height, four hundred paces in length, and pitch dark. It is a most disagreeable sensation to be dragged through this narrow passage at full speed, and in Egyptian darkness, after having had ample opportunity of seeing at the entrance the thousand abrupt jagged projections by which one is surrounded.' (Pückler-Muskau 1832, 286-288. His *Briefe eines Verstorbenen* was translated as *Tour in Germany, Holland and England ... By a German Prince*).

An English diarist visits Penrhyn Quarry

Penrhyn Quarry was also a tourist destination for visitors from the United Kingdom. The diarist Anne Lister of Shibden Hall in Yorkshire described it in 1822.

'.... we turned to our left this morning to Nant Frayon – we turned off to the slate quarries to the left as we returned from Ogwen Pool at the last turnpike before Llandegai – owing to some men standing by we took a round in going & were 20 minutes from the high road to the quarries – we returned another way in 10 minutes – the quarries very well worth seeing – shewn us by an overlooker John Hughes. A better sort of workman allowed 14/- a week – 8 hundred & 2 or 3 men employed in all the quarries (belonging now to Mr Pennant who succeeded to the estates of the late Lord Penryn, & who, Evan Jones the Snowdon guide told us had 28, 000 a year clearing 18, 000 by the quarries – we saw the largest quarries 450 men employed in it – they were pulling down huge masses of slate with ropes – or rather the ropes were fastened to or about the rock for the men to climb up by, & split or rend off the masses with large iron wedges – others were blasting the rock with gunpowder – this so lacerates the rock they only do it when other means fail – we went thro' a longish tunnel from one quarry to another 60 yards deep – slates different sizes – the largest £7 a thousand delivered at Port Penrhyn (close to Bangor) the smallest 4/6 a thousand – good workmen can earn £2 a month – each one pays 4/- a month towards clearing away the waste made in getting & dressing the slates – & what more is required is paid by Mr Pennant – the refuse is carted out along the side of the hill & has a striking effect (like so many pit-hills as we call them) at a distance.'

Figure 2.198. A sketch of Penrhyn Slate Quarry at the time of Anne Lister's visit in 1822. The artist, Francis Leggatt Chantrey (1781-1841), was the leading English portrait sculptor of the early nineteenth century.

2.b.xii Concise history and development of each Component Part, including conservation history

Component Part 1: Penrhyn Slate Quarry and Bethesda, and the Ogwen Valley to Port Penrhyn	
Sixteenth-century:	Slate quarrying on mountain slopes by local partnerships.
1782:	Richard Pennant, Lord Penrhyn, begins significant investment in Penrhyn Slate Quarry and in a slate-carrying road to the Menai Straits at Abercegin or 'Port Penrhyn'.
1801:	Railroad from the Quarry to Port Penrhyn completed.
1802:	Slate-slab mill opened.
1820s-1840s:	Neo-Norman Penrhyn Castle constructed, and Penrhyn Park reconfigured.
1840s:	Reconfiguration of Quarry, involving drainage levels and water-balance shafts.
1870s:	New steam railway replaces the original railroad.
1900-1903:	Prolonged strike at the Quarry.
1951:	Penrhyn Castle taken over by National Trust.
1960s:	Modernisation of the Quarry; new workings initiated, old workings abandoned, railway and slate-slab mill disused. Quarrying is henceforth concentrated on new workings to the southwest of the old Quarry which continue today. Port Penrhyn remains in use.
1990s:	Slate-slab mill conserved by Gwynedd Council as light industrial units.
2017:	Heritage-compatible tourist attractions open at relict Quarry.

Component Part 2: Dinorwig Slate Quarry Mountain Landscape	
Eighteenth-century:	Slate quarrying on mountain slopes by local partnerships.
1787:	A Caernarfon partnership develops the Quarry, building roads and using lake-transport.
1820:	Thomas Assheton Smith assumes full control of the Quarry.
1825:	Dinorwig Quarry Railroad completed to connect Quarry with a harbour on the Menai Strait.
1842:	Dinorwig Quarry Railway completed to connect Quarry with a harbour on the Menai Strait.
1860s:	Quarry Hospital opened.
1870:	Quarry Engineering Complex completed.
1961:	Dinorwig Quarry Railway ceases operation.
1969:	Quarry closed.
1971:	The first section of the Llanberis Lake Railway opens on part of the formation of the former Dinorwig Quarry Railway.
1972:	Quarry Engineering Complex re-opened as Welsh Slate Museum and the North Wales Quarrying Museum, now National Slate Museum.
1982:	Commissioning of Electric Mountain hydro generation scheme in Dinorwig Slate Quarry.
Early 1990s:	Gwynedd Council opens area adjacent to Quarry Engineering Complex as Padarn Country Park.
1998-9:	Inclined plane at Vivian Slate Quarry conserved and returned to use by National Museum of Wales; iron suspension waterwheel of 1870 in National Slate Museum conserved and returned to use by National Museum of Wales; quarry houses from Blaenau Ffestiniog (Element 5.6) re-erected on site to illustrate historic way of life in the slate communities.
2015:	Dinorwig Slate Quarry Hospital reopened as a museum following investment by Gwynedd County Council and European Union.

Component Part 3: Nantlle Valley Slate Quarry Landscape	
Roman to Medieval period:	Slate quarrying on mountain slopes by local partnerships.
1800:	Squatter-settlements begin on Cilgwyn Mountain.
1828:	Nantlle Railway to sea at Caernarfon opened.
1840s:	Work begins at Dorothea Slate Quarry.
1850s-1860s:	Influx of population to the Valley as quarries expand; existing farm-houses adapted as quarry dwellings
1904-06:	Dorothea Slate Quarry Cornish beam engine installed.
Early twentieth-century:	Electrification of Pen yr Orsedd Slate Quarry and installation of 'Blondin' ropeways.
1930s:	Contraction of industry; major social hardship.
1970:	Dorothea Slate Quarry closes.
1999:	Conservation of former barracks in Nantlle Village as business units and community centre.

Component Part 4: Gorseddau and Prince of Wales Slate Quarries, Railways and Mill	
Early nineteenth-century:	Limited slate quarrying on mountain slopes by local partnerships.
1856-7:	Major investment in Gorseddau Slate Quarry, railway, Ynysypandy Slate-Slab Mill and Treforys village.
1864:	Construction of slate-slab mill to serve Prince of Wales Slate Quarry.
1866:	Final abandonment of Gorseddau Slate Quarry, railway, Ynysypandy Slate-Slab Mill and Treforys village.
1875:	Construction of Gorseddau Junction & Portmadoc Railways to serve Prince of Wales Slate Quarry.
1890s:	Final abandonment of Prince of Wales Slate Quarry and Gorseddau Junction & Portmadoc Railways.
1981:	Purchase of Ynysypandy Slate-Slab Mill by Snowdonia National Park; conservation and consolidation.

Component Part 5: Ffestiniog: its Slate Mines and Quarries, 'city of slates' and Railway to Porthmadog	
1760s:	Quarrying of slate for export markets begins.
1800 onwards:	Capitalised partnerships lease slate quarries from the Oakeley estate and other landowners.
1807-1811:	Building of 'Cob' sea-defence leads to creation of a harbour at Porthmadog.
1820s:	Major capitalisation from English financial centres including *Liverpool – Maritime Mercantile City*; underground workings begin.
1836:	Opening of Ffestiniog Railway to Porthmadog Harbour.
1850s:	Steam power applied to large mills for processing slate.
1863-1872:	Transformation of Ffestiniog Railway by introduction of steam traction and passenger carriage.
1870:	International visit by engineers and government officials to Ffestiniog Railway.
Early twentieth-century:	Adoption of electrical power by quarries.
1930s:	Contraction of industry; major social hardship.
1946:	Closure of Ffestiniog Railway.
1955-1982:	Progressive re-opening of Ffestiniog Railway throughout its length.

1972:	'Quarry Tours' open in Llechwedd Slate Quarry.
1975:	Plas Tan y Bwlch reopens as the Snowdonia National Park's residential Study Centre.
2015:	A community initiative begins conservation of quarry dwellings; heritage-compatible tourism ventures at Llechwedd Quarry.

Component Part 6: Bryneglwys Slate Quarry, Abergynolwyn Village and the Talyllyn Railway	
1860s:	Investment by Nantlle entrepreneurs in Bryneglwys Slate Quarry,
1864:	Purchase of quarry lease by Lancashire industrialist William McConnel and formation of the Aberdovey Slate Company; construction of Abergynolwyn village begins.
1866:	Talyllyn Railway completed to connect the quarry with the main-line network and to carry passengers.
1946:	Last movement of slate from Bryneglwys Slate Quarry.
1951:	Operation of Talyllyn Railway taken over by Preservation Society.